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DR. LARDNER'S LECTURES.

(Continued from p. 143.)

If a single force act on a body, it must move in the direction of, and in proportion to that force. For if it move quicker, it must possess some moving power of itself, and, consequently, cannot be inert; which is impossible. The same may be said if it moves slower.

In speaking of velocity there are two things to be attended to, viz. time and space. A mail-coach may travel on a road, and so may a wagon; they may travel over the same space, but yet not with the same velocity, because the time is not stated. Again, the coach may run for six hours as well as the wagon, although the velocity may not be the same, as the space gone over is not given.

But when the time and space are both given, then the velocity may be known by the product of these two. It would be impossible to multiply the mere idea of time by that of space, therefore a certain standard is fixed for them; thus a second is the unit of time, and the foot is that of space, and the velocity means the number of feet passed over in a second, or the unit of time.

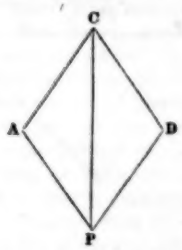
In the last case only one force has been supposed to act; now suppose there are several.

In the first place, suppose they all act in the same direction and the same straight line. The effect is here found by adding the amounts of the different forces, and which will be equivalent to the given forces.

The next case is when there are two forces acting in the same straight line, but in opposite directions. Were they equal, they would keep the body on which they acted in equilibrium; but if one have a greater velocity than the other, their difference will be the effect produced, and which will be exerted in the direction of that which has the greater velocity. Thus, if A moves with a velocity of 10, and B only with that of 8, then the body will be projected with a velocity of (10—8=)2, and in the direction of AB.

The next proposition is when there are several forces acting upon a body, but all in the same straight line, though not in the same direction, to find the effect. The sum of all forces acting in one direction must be subtracted from that of the opposite forces, the difference will be the effect produced.

What is said of motion may also be applied to pressure, excepting that the latter does not produce motion.



If the forces act neither in the same direction nor in the same straight line, the foregoing rules will not hold good. Suppose there are two forces, A and D, acting on a body P in the different directions AP and DP, it is required to know what single force will produce the same effect on the body P. Let the line AP bear the same proportion to the force A as DP does to D; thus let it contain as many inches as the force has pounds, &c., then draw the lines AC, DC, parallel to DP, AP, and the diagonal CP of the parallelogram ACDP will be in the same proportion to, and in the same direction as the force required. This figure is called the parallelogram of forces. This rule is not confined to pressure, but will also apply to motion, for the body P would move along the diagonal PC in the same space of time when moved by the two forces A and D together, as it would move along either line PA or PD, when impelled by either of the forces singly.

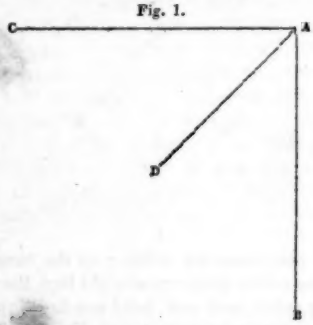
A proposition exactly converse to the

composition is the resolution of forces, viz. if one force be given to find what two forces are mechanically equivalent to that force. It is very easy to a person acquainted with the former, to find an answer to the present proposition. It is only to describe a parallelogram on the force taken as a diagonal, and the two sides will be the required forces.

The composition differs from the resolution of forces, inasmuch as the former is a determined and the latter an undetermined problem; for in the former case the single force is the only one into which the two given forces can be compounded, whereas there are several pairs into which a single force may be compounded.

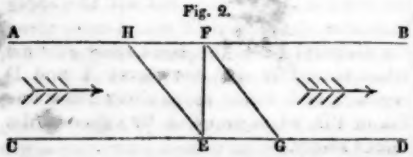
These two problems are very essential, as the whole doctrine of mechanical powers consists in nothing but the composition and resolution of forces; for any weight to be suspended by a crane or other machine is resolved into two weights, whereof one is thrown upon the fulcrum of the machine, while the other is balanced by the power.

Fig. 1.



There are several familiar instances by which these problems may be illustrated. Suppose a ship A (fig. 1.) were in a current running in the direction AC, and that the wind were blowing in the direction AB, and would impel the ship with the same velocity as the current would were they acting singly, it would neither move along AC nor AB, but along the diagonal AD. Again, suppose a person wished to row a boat across a river (which has a current) so as to arrive at a point exactly opposite to that from which he sets out.

Fig. 2.

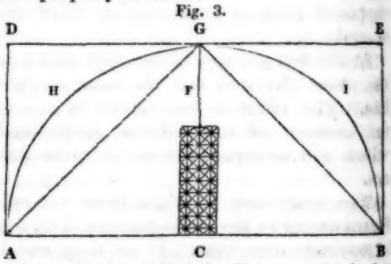


Let the two parallel lines AB and CD (fig. 2.) represent the sides of a river, the current of which runs in the direction of the arrows, and that E is the point from which he sets out, and F that he wishes to reach. Now, it is evident that were he to row exactly across he would be carried a considerable way down the stream by the force of the current. Therefore he must row to a point higher up the river, and it is required to find that point. Now, let EG be the distance the boat would float down, were it carried along by the current alone, in the time that the man could row his boat across the same river were there no current. Then, from F draw FH in the direction FA equal to GE, and draw the lines HE and FG, which will be parallel. Consequently, the figure HEGF is a parallelogram, and as the boat would move when impelled by one force (the current) along the side EG in the same time it would be moved by the other (the oars) along the other side EH, it will when impelled by them both together move, in the direction of the diagonal EF, and would arrive at the point F required.

Every one knows the effect produced by leaping from a carriage during its progress. There are two forces to be here compounded, viz. that produced by the velocity of the carriage, and that by the muscular effort exerted on the occasion; consequently, instead of alighting on the ground at the point required, the person making the leap would reach the ground at a place considerably advanced.

Most persons may have seen the equestrian feat of leaping through a hoop or over a bar, &c., and alighting on the back of the horse again; this is effected by means of this property of inertia.

Fig. 3.

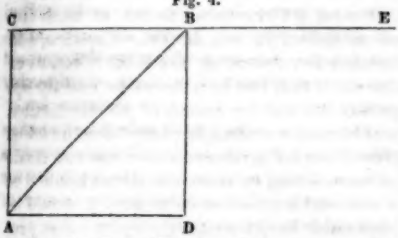


Let AB (fig. 3.) be the line on which the horse is supposed to run, and CF the board or obstacle to be leaped over by the rider. In order to alight on the horse again, he must not leap forward, but only upwards, and must so measure his effort that he may ascend from A to D and back again in the time that the horse would take to run from

A to B; consequently, he would arrive at D in the same time that the horse would reach C; thus his muscular effort may be represented by the line AD, while his velocity (retained by his inertia) may be shewn by AC, and these two forces when combined would move him in the direction AG, and he would reach G at the same time the horse would be at C. By saying he would move along the diagonal AG, his upward motion is considered as uniform, but it is not so, for it is quickest at first, and gradually becomes slower till he reaches as high as D, when he would descend; therefore the force AD being at first stronger than that of AC, he will ascend along the curved line AHG. But he is now at G while the horse is at C. Now he has not lost his velocity yet, but keeps it acting in the line GE, while his gravity acts in the direction GC, consequently, he will descend along the diagonal GB of the parallelogram GEBC, or rather for the same reason as given before, along the curve GIB, and will arrive again on the horse's back at B.

If a non-elastick body strike another non-elastick body in a slanting direction, it will not remain stationary, by reason of the resolution of the forces.

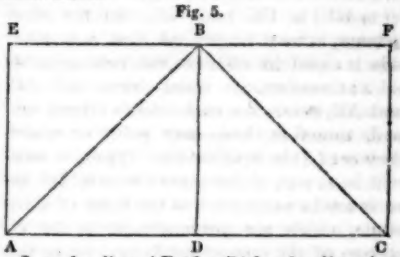
Fig. 4.



Let the line AB (fig. 4,) represent the direction and force of the body A, and let CE be the plane against which it strikes at B. Now, by forming the parallelogram CADB, of which the line AB is the diagonal, it is evident from the principle of the resolution of forces that the force AB may be also expressed by the two forces CB and DB; but the force DB is destroyed by the non-elasticity of the bodies, while that of CB is not at all lessened; consequently it will move in the direction BE.

But if the body and the plane be both perfectly elastick, the motion will not be produced by the resolution alone, but also by the *re*-composition of forces. It is this which explains the angle of reflection. A perfectly elastick body striking another perfectly elastick body or plane, is rebounded with the angle of reflection equal to that of incidence. It is a well known fact (or property) that two bodies of this kind when struck together, will return with exactly the same force.

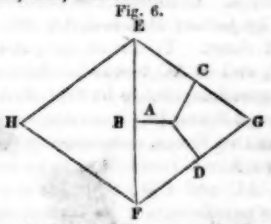
Fig. 5.



Let the line AB (fig. 5,) be the direction and force of the body A, striking against the plane EF, at the point B. Now, as in the last figure, by drawing the parallelogram BEAD, the diagonal AB may be resolved into the forces DB and EB. Then, by the body hitting the plane, in the direction DB, it will return in that of BD, and with the same degree of strength, while the force EB is continued to BF, consequently the motion will then be described by the lines BF and BD, and, by completing the parallelogram BDCF, the force may be represented by the diagonal BC, and the angle FBC will be found to be equal to EBA, or, in other words, the angles of reflection and incidence are equal, that is, if the bodies are both perfectly elastick, but the angle of reflection diminishes with their elasticity, until they are both non-elastick, when the angle is lost altogether as before shewn.

The next proposition is, if three forces act on the same point, it is required to discover under what circumstances they will keep that point in equilibrium. Thus, suppose that point to be at A (fig. 5,) and the three forces to be expressed by the three lines AB, AC, and AD.

Fig. 6.



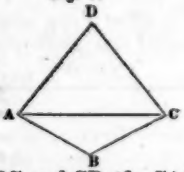
Draw the lines EF perpendicular to AB, also EG to AC, and FG to AD. Now, if the side EF of the triangle EFG, bears the same proportion to AB as EG does to AC, and FG to AD, then these three forces will keep the point A, on which they act, in

equilibrium. To prove this, complete the parallelogram FHEG, by drawing FH parallel to GE and HE to FG; therefore the diagonal FE, will be equal in effect to the two forces FG and FH, or (as FH is parallel to GE) to FG and GE. In the same manner, it may be proved that any other side is equal in effect to the two opposite sides; therefore, the three forces AB, AC, and AD, neutralize each other's effects, and will, therefore, keep any point on which they act (A) in equilibrium. Thus, a point will be at rest, if the three forces which act on it are in proportion to the sides of a triangle, which are perpendicular to the direction of the respective forces; or, as this rule may be otherwise expressed—three forces will keep a point in equilibrium, if they are in proportion to the sides of a triangle, which are equally inclined to the direction of those forces. This figure is called the triangle of forces.

It may be observed, that the limits of a resultant, produced by the composition of two forces, are the sum (when they act in the same,) and their difference, when they act in opposite directions, or as it is otherwise expressed, the resultant of two forces, can never be less than the difference, or greater than the sum of those forces.

The next thing is when three forces are given in the same plane, in different directions, to find a single force, whose effect shall be equal to those three.

Fig. 7.



Let AB, BC, and CD, (fig. 7,) be the three given forces. Complete the parallelogram ABCD, by joining DA, and AD will be the required force. To prove this, draw the line AC, and as AC would be the diagonal, were a parallelogram to be described on the two sides AB and BC, it may be substituted for those two forces, consequently there are only two forces remaining, to be attended to, viz. AC and CD; when, it is evident, that if a parallelogram be formed on these two lines, the diagonal AD would be a single force, producing the same effect as the two AC and CD; but AC was proved to be equal to AB and BC, therefore, AD is in the single force whose effect is equal to that of the three given forces, AB, BC, and CD.

The next proposition, viz. When will four forces acting on a point, keep it in equilibrium? will only require a repetition of the last case, as it is well known that a force, whose effect is equal to that of three others, will, if opposed to them, neutralize their effects, and keep a body in equilibrium.

The same rules also apply to motion—Suppose a body receives three impulses, the one moving along AB (fig. 7) in one second, and the others along lines parallel and equal to BC and CD, in the same time. The effect produced will be that the body will move along AD in one second.

By the same method of proceeding as in the last proposition, a single force may be found equal in effect to any number of given forces, and also under what circumstances any number of given forces will keep a body in equilibrium.

Hitherto, all the forces have been supposed to be acting on the same point, but as that is a thing, which seldom or never occurs, the next proposition must be, what effect will be produced by several forces acting on several points?

This problem would be an indeterminate one, as the data on which the results would proceed would be insufficient. As for instance, if a force were to act at each end of an inflexible rod in one direction, and another force were to act in the centre of the same rod, but in a direction exactly opposite, the rod, by reason of its inflexibility, would continue straight; but, the same effect would not be produced, were the rod made of whalebone, or were the forces applied to a piece of rope—consequently, it would be impossible to determine the exact effect produced by different forces on different points of any body, or system, unless those points are connected by some known law.

But, when forces are acting on the same point, it is immaterial whether it is a particle of a solid, a fluid, or of gas—the same principles are applicable to all descriptions of bodies.

It may be proper to explain the proper meaning of the word "System," used above.

"System" is a more general phrase than "Body"—a body is a mass of one constitution or texture, as a rod of iron, &c. But, when it is separated in different places, and joined at one place by a hinge, at another, by a rope, &c., then it will be called a system, although, when the parts of a system are connected by a law, in virtue of which, the same effect will be produced on

all its parts, then it partakes of the properties of a body.

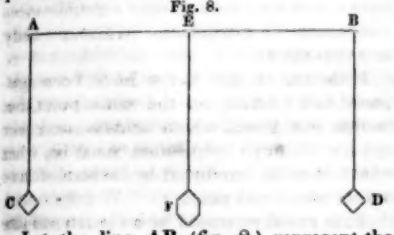
A solid body is the most perfect system, and is supposed not to change its figure.

If any number of given forces act on any number of given points in the same plane, it is required to determine what effect will be produced?

(In the following propositions all the forces are supposed to act on an inflexible rod, the weight of which is not taken into account.)

First.—Let there be two equal forces acting on different points of the same body and in parallel directions, it is required to determine what their mechanical effect will be, or in other words, what single force will produce the same effect?

Fig. 8.



Let the line AB (fig. 8.) represent the body on which act the two equal forces or weights C and D in the directions AC and BD.

Now a weight (F,) double C or D acting on a point (E) equidistant from the two given weights, and in the same direction, will produce the same effects as the two forces C and D acting together from the points A and B.

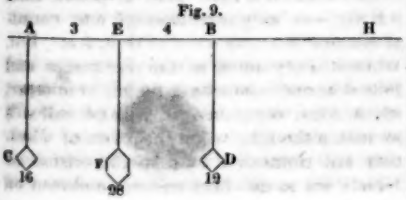
It is of no consequence how great be the distance between the given forces so long as the single force is exactly equidistant from both of them.

Secondly.—Let the two forces be unequal, it is required what is the single force productive of the same effect?

There are two things to be here determined; viz. the magnitude, and the place of the required force.

With regard to its *magnitude*, it is evident that it must be equal to the sum of the two given forces.

Fig. 9.



Let the line AB (fig. 9,) represent the body to be acted upon by the unequal weights or forces, C and D, (viz. C=16 and D=12) hanging from the points A and B; consequently the required force will be (16+12=) 28.

With regard to its *place*, the distance between each given weight and that required, must be proportional to the opposite weight. Thus supposing that the distance between A and B be 7 inches, then the point E, on which the required weight F acts, should be distant from A 3 inches, and from B 4 inches, because as C : EB :: D : EA, or as 16 : 4 :: 12 : 3, therefore a weight F=28, hanging from a point E at these distances, will be equal in effect to the two (C and D) together.

These distances can also be found by common arithmetick. The rule is—*multiply the weights by their distances from any point in the place beyond those on which they act, the sum of which products, divided by the sum of the two weights, will give its distance from that point.* Thus, as in the last figure, let the distance AH be equal to 18 inches, and BH to 11 inches, then it will be

$$\frac{\overline{C \times AH} + \overline{B \times BH}}{C+D} = EH \text{ or}$$

$$\frac{\overline{16 \times 18} + \overline{12 \times 11}}{16+12} = \frac{420}{28} = 15 \text{ inches.}$$

the distance from the point H at which the weight F must act.

This rule will serve for finding a single force equal in effect to any number of given forces in parallel and the same directions.

(To be continued.)

COMMUNICATION.] [FOR THE JOURNAL.

Mr. Editor,—Having glanced at the different measures for internal improvement in New-England and New-York, in my two former numbers, in this I propose noticing similar works completed and completing in Pennsylvania.

In these enterprizes, Pennsylvania was first in the field, and has expended more than any other state in the Union.

The Pennsylvania canal, so called, includes a number of canals running in different directions, and also known and frequently spoken of by different names. It consists of five divisions.

The *Transverse Division*, commences at Columbia and runs on the east branch of the Susquehannah to the mouth of the Juniata river; up the Juniata to Frankstown; thence by a rail-road, forty miles

over the Allegany; thence down the Kiskimenitas and Allegany rivers to Pittsburgh. Distance, 322 miles.

Middle Division, from the mouth of the Juniata up the Susquehannah to the boundary line of New-York. 204 miles.

West Branch Division, commences at Northumberland and extends up the west branch of the Susquehannah, seventy miles, to Dunnstown, beyond which it has not been located. It is, however, expected to be extended double that distance.

Eastern Division, is in the valley of the Delaware, commencing at Bristol, eighteen miles above Philadelphia, and running to Easton, sixty miles. This is also called the Philadelphia and Delaware canal. From Easton it is to be continued under the name of the Delaware canal, to meet the Delaware and Hudson canal at Carpenter's Point. 80 miles.

Western Division, otherwise called the Ohio and Erie Canal, extends from the mouth of the Kiskimenitas, up the Allegany and French creek, and thence to the town of Erie, 213 miles, uniting the waters of lake Erie and Ohio river. Only twenty miles of this division are yet completed. Greater progress, however, has been made in all the other divisions.

These five divisions constitute the Pennsylvania canal. All undertaken by the state, and to be constructed on state account exclusively; and together, amount to 949 miles.

Schuylkill Canal, extends from Philadelphia to Reading, and from thence to Mount Carbon, 108 miles. This canal is sometimes called (and perhaps with as much propriety) *Schuylkill navigation*; forty-five miles of its navigation being in the river; sixty-three, canal. It is finished, and cost about $20,000 per mile; half of which was advanced by a joint stock company; $50,000 by the state; remainder borrowed; 620 feet lockage; tolls in 1825, $87,000; double that amount in 1826, and increasing every year since. The company also realize $10,000 per annum for water rights and mill privileges. This canal passes through a tunnel 345 feet in length, seventeen feet wide, ten feet high.

Laxawaxen Canal, commences at the termination of the Delaware and Hudson canal, near Carpenter's Point, and unites with a rail-road at Honesdale. This canal is in fact, a part of the Delaware and Hudson, though frequently spoken of under the name of the Laxawaxen. It is forty-three and a half miles long; thirty-two feet wide at top; twenty at bottom, and four feet deep; has 615 feet lockage; cost $20,000 per mile.

Lehigh Canal, extends from Easton to Stoddardsville, forty-six miles, and connects the Morris canal with the Mauch Chunk rail-way.

Union Canal, extends from Reading to Middletown; connecting the Susquehannah and Schuylkill rivers, and uniting at Reading, with the Schuylkill canal, and at Middletown, with the great Pennsylvania canal. It is eighty miles long; thirty-six feet wide at top; twenty-four at bottom; four feet deep; 480 feet lockage. The summit level at Lebanon is ten miles in length. There is a tunnel through which this canal passes, 729 feet long, eighteen wide, and fourteen high.

Mauch Chunk Rail-Way, was constructed in 1827; with its branches is thirteen and a half miles long; a single track cost $3,050 per mile; connects the Lehigh canal with the coal mines of this name.

A rail-road, commencing at the termination of the Laxawaxen and Delaware and Hudson canal, connects that canal with the coal bed in Carbondale. This road runs 16 miles, and overcomes an elevation of 800 feet. This rise from the coal bed is surmounted by five inclined planes in three and a half miles of from 2000 to 3000 feet each. The cars are drawn up these planes by stationary steam engines. The inclination of this plane is from 1 in 20 to 1 in 12. This rail-road consists of a single pair of tracks; wooden rails capped with iron; cost $6,500 per mile.

Messrs. Robbins and Hayward say, "at first, such a system of inclined planes with stationary apparatus seemed formidable; but the dexterity with which they are managed, notwithstanding the short time in which they have been in operation; the facility and despatch which they give in surmounting great elevations; and their simplicity and cheapness, are strong arguments in favour of adopting them when abrubt acclivities are to be passed. It has been ascertained that more than 400 tons, per day, can be passed through this system of planes."

About forty miles of the Baltimore and Susquehannah rail-road, which was commenced last summer, when completed, will be within the limits of Pennsylvania. More than 150 miles of the grand rail-road from New-York to the Mississippi, (in favour of

which, considerable zeal is now manifested,) should it ever be constructed, will be in Pennsylvania; as also about the same length of the Chesapeake and Ohio canal. Not far from 1,600 miles of canals and rail-roads, within the limits of this enterprizing state, are projected, commenced, or completed; about 500 of which, is now in successful operation. More than two thirds of the whole is done, or to be done at the expense of the state.

Several of these canals and rail-roads were constructed solely for the transportation of coal, with scarcely no reference to the general interests of the community at large. Lands, however, in their vicinity have been brought into a state of cultivation; villages have sprung up; increased value has been given to extensive tracts of country, and many unforeseen advantages have already been realized by agriculturalists and others for many miles on each side of these canals

Such improvements not only open a cash market to the farmer for his produce, but give him many of the heavy articles of his own consumption at a much cheaper price. At the same time the expenditure of such large sums of money in the interiour, by making money plenty where there was none before, has substituted cash prices, and a money trade for endless credits and delusive barter bargains. Nor is pecuniary prosperity all, nor by any means the most valuable consideration realized by these enterprizes. Intellectual and moral culture are rapidly progressing. So that while many other parts of the Union and the world are at a stand, and suffering under extreme depression and stagnation of business, Pennsylvania, taken as a whole, has for the last ten years been moving steadily, and in some parts, rapidly onward.

So much, however, of this prosperity as is attributable to the expenditure of money, merely, must of course cease with its cause, and may, perhaps, be followed by reaction, and produce a general state of pecuniary embarrassment, even heavier than that from which they have been relieved. This I know is feared; less, however, in Pennsylvania than elsewhere; more, probably, (at least oftener thought of and alluded to,) in Massachusetts than any where. The expenditure of large sums of money in any place, even for a worthless purpose, inevitably raises the value of property in its vicinity, and uniformly secures a temporary general prosperity. Permanent value must necessarily depend on utility, and expensive enterprizes, involving little or no real improvement, must, in the end, prove injurious. That this may be the result of some of the measures for internal improvement in Pennsylvania, is highly probable. The most sanguine believer in the value of railways and canals would, doubtless, admit that there was a point, beyond which, it would be imprudent to go. Whether Pennsylvania has reached or exceeded that point, time will soon begin to prove. To finish the improvements already commenced, the state must incur a debt of ten or fifteen millions. In this, however, there is nothing alarming, provided the income from these works is equal to the annual interest the state pays for the outlay. This, without doubt, will prove to be the fact in relation to many of her canals and rail-roads, while with others it seems impossible.

The *Transverse Division*, for instance, of the Pennsylvania canal, the object of which, is to secure the trade of Pittsburgh to Philadelphia, is, to say the least, an undertaking of more than doubtful expediency. If there were to be no other communication between the waters of the Ohio and Atlantick but this canal and the Mississippi river, the expectations from the former would be reasonable. But the Baltimore and Ohio rail-road, if it should terminate at Pittsburgh, will bring that place within 350 or 360 miles of Baltimore, which is quite as good a market for all the produce of the west, as Philadelphia, and which has some commercial advantages superiour to those of Philadelphia.

The Ohio and Chesapeake canal will bring Pittsburgh within 340 miles of ship navigation at Georgetown.

From Pittsburgh, by the Pennsylvania, Union and Schuylkill canals, to Philadelphia, is . . . . . 460 miles.
By the Pennsylvania canal and Columbia rail-road, ... 400 "
By the Baltimore and Ohio rail-road to Baltimore, ... 360 "
By the Ohio and Chesapeake canal to Georgetown, ... 340 "

Either of these routes, alone might, and undoubtedly would prove good property, which if they all go into operation, it seems hardly possible that either of them should result in any thing better than a ruinous speculation. Certainly, the Pennsylvania canals cannot be expected to maintain a successful competition.

MIDDLESEX.

The following article we select, as being of supposed interest to our readers, from a little work entitled "The Freedom of the mind," recently published by a clergyman in a small town in Massachusetts. The stranger comes to us in the popular character of lectures; a mode of instruction with which our readers are perfectly familiar; and which they, as members in part of the three associations, who are found in regular attendance, in the winter season, at their hall in Pearl street, may almost consider as having originated among us. The lectures in the work referred to, are seven in number. The following is from the second of them:—

An ancient philosopher is said to have told his impatient prince, that there was no royal road to mathematicks. Coming in our republican simplicity to the sovereign people, it may be as needful to say, *there is no republican road to learning*, or to those solid and lasting blessings which an enlightened people may enjoy. The Lyceum offers to bring them to the door of every man and woman who is willing to learn; but we assure you, as its organ to night, that even American genius, has never invented or formed a path, in which every body can travel to the heights of science, without the usual difficulties of a mountain road. The Lyceum does not offer you the improvement of your minds, without diligence and perseverance. Yet, in the true genius of our country, which regards all men as equal—nay, in the true spirit of Christianity, it does offer that improvement to men of every occupation, without respect of persons.

The hindrances without us are removed. It is only the hindrances within us which remain. These hindrances exist in the false and enslaving principles which have held whole nations in bondage; which, notwithstanding our release from all civil disabilities, hold this nation in mental thraldom. I am free to confess that I feel straitened still, by the cords which are not yet cast off; but half escaped, perhaps by means of advantages, not enjoyed by the mass of the people, let me as well as I can, show you the manacles which bind us, and persuade you to cast them off.

Of the enslaving maxims which we have inherited, I shall this evening select ONE: break this one fetter, and you will find a way to break the rest. Get your right hand loose, and you will soon be free.

The false and enslaving maxim which is to be considered this evening is, *that men of business and toil have no leisure for study and improvement.*

This maxim takes it for granted that the avocations and toils of life are so numerous and constant, as to prevent any regular and sufficient intervals for study and improvement; or that intervals of sufficient length and regularity are rendered useless by the unavoidable distractions and fatigues which they occasion: so that in our country, study and improvement are considered for the most part as the proper business of the learned professions, whose *whole* time in youth and manhood is separated to intellectual leisure. This is chain enough. If those who are occupied in the proper business concerns of life, and its severest toils, have *no* time for study, then is the great mass of society doomed to mental degradation; and the *independence of the mind* can never be declared, until the day is more than twenty-four hours long. But if every body has time, if men of the most busy and toilsome occupations have time for high mental improvement, then shall we need no congressional deliberations to announce that our minds are free, and no seven years' war to assert and establish our freedom. Each man will have the principle of freedom in his own bosom; and will be a nobleman and gentleman; a scholar and a philosopher, though he toil at the desk, or in the shop, or in the field, for his daily livelihood.

Do men say that they have no time? Did we ever hear of unceasing labour as the doom of any community, much less of ours? Labour no where employs all the time which is not occupied in sleep and in taking food. Suppose that twelve hours be spent in labour; eight in sleep; two in meals and recreation; are there not two hours left in every twenty-four? We ask for *one* of those two hours to be devoted to *study; hard* study; leaving the other for lighter occupations; study from day to day, and from year to year. This would give you 365 hours a year; 3650 hours in ten years, and if you add three hours for religious study every Sabbath, it will give you 1560 hours more; the sum total of which will be 5210 hours; or about 868 days of six hours each, so that you secure out of ten years, about two years; and from twenty, four; which, so far as time is required, is

sufficient to complete as extensive and varied a course of study, adapted to your own taste and wants, as can be pursued from entering to leaving college.

Except in cases of extraordinary difficulty—in all cases of mere ordinary arrangement of the labour, even of poor men—this hour can be commanded and separated to its sacred purpose. With some, it may be taken at the beginning of the day; by more, at the end; by some, at the interval of rest at mid-day, or by subdivision in different parts of the day. Each one must find it for himself. If he has not yet found it, and asks where it is, we tell him to look for it among his hours of vacancy, which most men, by habit, waste unconsciously, and without conscience. The hour exists, unemployed, asking the privilege of becoming sacred to the regular and progressive culture of the mind.

1. Rise early. If you waste a morning hour in bed, that is the hour which wisdom claims of you.

2. Spend no time in listlessness and vacancy. If you have an hour in which you are listless and vacant, unemployed in body and mind, seize that hour for study. You can devote that hour without any loss.

3. Spend no time in idle talking, vulgarly called gossiping. Consider the profit given or received, in your social intercourse; and if any part of it is found unprofitable; if you find you have little or nothing to say, as you rove, or stand, or sit with your neighbours, stay at home and study one hour a day, and you will become so much richer as a companion, that your neighbours will suffer no loss.

4. To some, another rule may be sufficient, viz: read less and study more.—There is an immense fund of light reading—newspapers, stories, novels—which occupy hours a day, where *one* hour cannot be set apart for study. Set apart *one* hour for thorough and continuous study; whatever spare time, besides, you may have, will be sufficient for lighter reading.

5. If your necessary occupation does in fact so engross every hour of the day, plan your business better. If you have no time except to eat, work and sleep, it is best to alter an arrangement suited only to an animal, and to adopt one suited to a man. Your business will not suffer. Perhaps you will become so much more skilful as to make amends; if not, work a little harder while you do work; an hour of studious rest will make you more vigorous.

I have no doubt that, except in extraordinary emergencies, the hour a day may be secured. Its aggregate value in a course of ten or twenty years we have placed at two and four years of separate study. In the forty years between twenty and sixty, a persevering student would have secured himself eight years. The stock of information amassed in those years should exceed the ordinary amount of a liberal education. But the hour a day has peculiar advantages.

1. The *hour* a day can be employed with more vigour than all the hours of a mere student. In 365 hours out of as many days, much more vigour of mind can be employed, than in the same number of hours out of forty or fifty days. One hour a day is worth a great deal more than one tenth part of ten hours a day. The mind grows fatigued and enfeebled by the continuance of mental effort and bodily inaction. Each succeeding hour is apt to be spent with less vigour and to less effect. Every student knows this by painful experience. I am persuaded that one hour a day, to all the purposes of mental improvement, is not as one to ten compared with *ten* hours, but much more likely as one to five, i. e. the student who can employ ten hours a day, is in this view only five times better furnished with leisure for improvement than the man who, from a day of labour and business, and intercourse with men, saves only *one* hour. It is quite possible that some bookworms study too many hours; and that they would gain in vigour of application, a full compensation for a curtailment of one half their hours.

I am well aware of the difficulty which may be felt in bringing the mind to vigorous and intense study for a single hour. The thoughts of business left undone, or of business to be undertaken, the cares and perplexities of life, will crowd in; and the hour will be fully over, before the mind gets fairly settled to its studious employment. I know the evil. Every student knows that it has cost him more than one hour, to calm down his wavy and disturbed mind; more than one hour, before it could part its hold upon passed and coming affairs, and be ready to grapple with the subject matter of its retired consideration. The difficulty is not confined to men of labour and business, and the remedy is the same with all. A steady effort will soon induce a habit; and whether for one hour, or for half an hour, or for a quarter of an hour, you will soon find yourself able to turn away from any employment

and conversation, and to bury yourself in the depths of science and philosophy.

BLOW-PIPE SIMPLIFIED.

A modification of the blow-pipe has been contrived by *M. Danger*, and is described in the "Bulletin d'Encouragement," which has simplicity and cheapness to recommend it. A wooden clamp, with a screw underneath to attach it to the edge of a table, has a hole bored vertically through it in front, and to this hole underneath is attached a tube, to the other end of which a bladder is tied. Another tube, which terminates with a jet piece, is attached to the hole above. It is obvious that if this bladder be inflated, and its sides pressed together by the knees of the operator, or by any other means, a stream of air will issue through the jet, and maintain the flame of the lamp. To keep up the supply of air, a mouth-tube is inserted into a lateral opening in front of the clamp, and which reaches upwards to a convenient height for the mouth. By blowing into this tube occasionally, the supply of air in the bladder is preserved, and to prevent its return a valve is placed at the end of the mouth-tube. This valve is simply a piece of cork, fashioned to a conical opening in a tin or brass piece adjusted to the end of the tube. A short wire, fastened to the cork, passes freely through a little guide, and is provided with a catch to keep it just within the conical opening. The mouth-tube may consist of two pieces, one sliding into the other, so as to be readily adjusted to any convenient length. The lamp should be covered, when in action, with a hood having two openings, one in front for the admission of the blow-pipe, and the other opposite for the exit of the jet of flame. The air may be forced out of the bladder mechanically, by surrounding it with a coarse net of twine, and hanging a weight to the bottom of it. This blow-pipe unites great simplicity to cheapness and facility of adjustment.—(Bull de Encour.)

Stone-Butter.—On the banks of the Kamer de Maslo, (Siberia,) there is a fossil or earthy substance of a yellowish cream colour called, by the Russians, Kammenozemaslo, or stone-butter, which is eaten in various ways, and is not disagreeable to the taste. It is probably similar to the mineral found in corresponding latitudes on the banks of the M'Kenzie, which Captain Franklin states is used by the natives for food in periods of famine. It oozes out of the rock in many parts of Siberia, and when exposed to the air hardens; but in wet weather it becomes soft, and even liquid. That found on the M'Kenzie resembled a kneaded paste, and was used by the traders as stated by Captain Franklin, for whitening their apartments.—(Foreign paper.)

Greenland Lamps and Kettles.—According to Crantz, the potstone of which the natives of Greenland make their lamps and kettles, occurs but rarely in that region, though it is an article of trade among them. They carry utensils of it to districts where it is not found, and barter them for provisions, furs, &c. They are sometimes sent as presents to persons of distinction in Denmark, where they are highly valued, as it is thought that articles of food prepared in them are finer than when done in metalick vessels. The stone is soft and compact, and more easily carved or turned than wood. It does not crack or scale off, but hardens after being wrought, and grows firmer by fire. When rubbed with oil it acquires a beautiful porcelain smoothness.—*Geology of the Arctick Regions.—Silliman's Journal.*

Animal Weather Glass.—At Schwitzengen in the post house, we witnessed for the first time what we have since frequently seen, an amusing application of zoological knowledge for the purpose of prognosticating the weather. Two frogs are kept in a glass jar about 18 inches in height, and 6 inches in diameter, with the depth of 3 or 4 inches of water at the bottom, and a small ladder reaching to the top of the jar. On the approach of dry weather the frogs mount the ladder, but when wet weather is expected, they descend into the water. These animals are of a bright green; and, in their wild state, climb the trees in search of insects, and make a peculiar singing noise before rain.—*Mag. of Nat. Hist.*

Economical Water-Colour for Rooms.—Take a quantity of potatoes and boil them, then bruise them, and pour on boiling water until a pretty thick mixture is obtained, which is to be passed through a sieve. With boiling water then make a thick mixture of whitening, and put it to the potatoe mixture. To give colour, if white is not wanted, add the different coloured ocres, lamp black, &c. according to circumstances. This paint dries quickly, is very durable, and has a good appearance to the eye.—*French Paper.*

An Effectual Means of Curing a Cut, Bruise, or Burn, is said to be the inside coating of the shell of a raw egg. Apply the moist surface to the wound; it will adhere of itself, leave no scar, and heal any wound, without pain, more speedily than any salve or plaster in the universe.

We avail ourselves of the following translation of M. Arago's* Notes on the explosion of boilers of steam engines, as prepared for the Journal of the Franklin Institute. It occupies several pages of that journal, and is to be continued. The subject is of so much interest that we feel confident it will not be thought too long by our readers.

The steam engine may be considered as the noblest work of human ingenuity when we shall have succeeded either in preventing the explosions to which it is liable, or the destruction of property and of human life, which are too frequently the consequence of such accidents. This problem, it must be confessed, has not yet been solved completely, although it has occupied the attention of men skilled in both science and the arts. The ingenious contrivance of Papin, known under the name of the *safety valve*,† is sufficient, it is true, in *common cases*, but there are circumstances, happily not common, in which these valves do not answer the purpose for which they are applied, and are even dangerous. The object of this paper is to point out these circumstances as far as the imperfect state of our knowledge will permit, the causes which lead to them, and the more or less effectual means of avoiding them.

I shall at first set before the reader a brief account of all the explosions which are known to me, and which have been witnessed or described by experienced engineers. In this way we shall be able to examine to advantage the different explanations which have been given of these dreadful accidents.

Examples of the most violent explosions which have taken place up to this time.

At a large distillery, called *Lochrin*, near Edinburgh, the proprietor, with a view to economy, undertook some years since to substitute steam distillation in place of the old mode. Large metallick tubes, through which steam circulated, were made to pass and repass through the vessels containing the liquids to be distilled. The steam was generated in a boiler of forged iron of more than a third of an inch in thickness, 37 feet in length, three feet in width at the bottom, and two feet at the spring of the top, and four feet in height. The weight of this boiler was 18 tons. On the top of this boiler were two safety valves so arranged as to open when the pressure of the steam within the boiler should exceed four atmospheres, or 60 lbs. to the square inch. To guard against any addition of weight by the workmen, one of these valves was inclosed in a grating fastened by a lock.

This immense apparatus was put in operation on the 21st of March, 1814. Twelve days from this time it no longer existed, the whole had been destroyed by an explosion.

In bursting, the boiler was divided into two distinct and unequal parts. The upper portion, composed of the cover and the two sides, weighed 14 tons. It was thrown upwards with such force that after penetrating a brick arch and the roofing of the building, it rose to the height of 70 feet. This enormous mass fell at a distance of 150 feet from its former bed, upon one of the buildings of the distillery, passed through it and crushed a large trough of cast iron situated upon the ground floor of the building. Happily but two of the workmen were near the boiler when it burst. These were the only persons killed, although other workmen were in the adjoining buildings, and the boiler, like the crater of a huge mine, threw in every direction, and with prodigious violence, quantities of tools and fragments. The limbs of one of the workmen killed were separated from the body; it is a remarkable fact that the limbs remained in

* Dominique-François, born at Estagel, in Perpignan, Feb. 28, 1786, as early as 1804, was an instructer in the polytechnick school. In 1805, he became secretary of the *bureau des longitudes*. With Biot, and the Spanish commissaries Chaix Rodriguez, after Delambre and Mechain had measured the arc of the meridian between Dunkirk and Barcelona, he continued the measurement to the island Formentara. When the French army entered Spain, A was imprisoned by the Spanish officers, and remained several months in Rosas. Attempting to return to France by sea, he was taken and carried to Algiers by a corsair. In 1809, the then French consul procured his freedom. He had, fortunately, preserved his apparatus, and all his observations and calculations. The latter formed a continuation of the *Base du Système métrique*, published before, by the institute, under the following title: *Recueil d'Observations géodésiques, astr. et phys. exécutées par Ordre du Bureau des Longitudes, en Espagne, pour déterminer la Variation de la Pesanteur et des Degrés terrestres sur le Prolongement du Méridian de Paris; réd. p. Biot et Arago;* 4to. A. took the place of Lalande in the national institute, and, in 1816, became a member of the 3d class of the academy of sciences. At present, he is principally devoted to physicks, particularly to investigations relating to the theory of light and galvanism.—(Encyclopædia Americana.)

† This valve, the common safety valve, is described in a subsequent part of this paper.—TRANS.

the distillery while the body was found at a distance out of the building, amidst the fragments.

The line along which the boiler was torn was perfectly horizontal, and followed a row of nails as regularly as if the iron had been cut with strong shears.

The boiler, on the plan of those of Watt, was *convex to the interior* on the side next the fire, in this way it formed a sort of arch which allowed the flame from the furnace to play in the centre, almost of the liquid. After the explosion, this side was found to be *convex outwards*, so strong had been the pressure from within. This change of form might have been predicted, but if the examination made after the accident had not proved it, it would have been difficult to believe that the bottom of the boiler of 4 tons in weight, and which bore such evident marks of the enormous *downward* pressure to which it had been subjected, would be *raised* to a height of 14 or 15 feet, and carried to some distance from the mass of masonry upon which it had been placed.

It is important to remark, that no circumstance authorizes the supposition that the accident at Lochrin depended upon the imperfect construction of the safety valves. I have already said that one of them was under lock, so that we cannot suppose an overcharge of the valve.

Second example, characterized by the simultaneous explosion of several boilers.

The steam boat *Rhone*, constructed by Messrs. Aikin and Steel, was intended to ply as a tow-boat between Arles and Lyons. It carried a very large engine, well made at Paris, in the works of la Gare, and fed by four boilers of laminated iron each 52 inches in diameter. Since the accident, it has been found that the metal of the boiler was, in many places, not more than $\frac{1}{4}$ of an inch in thickness.

On the 4th of March, 1827, while preparing for a trial which was to be witnessed by the authorities of Lyons, the boilers burst. Several persons, Mr. Steel among others, were victims of this accident. Some of the spectators on the wharf were killed by splinters from the boat. The whole deck was thrown to a great distance, the braces and the pipes of the chimneys, weighing more than 3 tons, were projected almost vertically to a considerable height; the top of one of the boilers fell 330 yards from the boat; it did not weigh less than 2 tons.

This horrible catastrophe was the inevitable consequence of the imprudence of the engineer. Disappointed in not being able to stem the current with as great rapidity as he had expected, Mr. Steel fastened down the safety valves of the four boilers. This fact, however incredible it may seem, has been proved to be true. We have remarked that there were four boilers in the boat. It is certain that two of them burst almost at the same instant. If I have been correctly informed, in drawing up from the river a third, not long since, it was found that this also had burst. This bursting of two, and perhaps three boilers, at the same moment of time, is a remarkable fact, and one which will be referred to when we shall speak of the different explanations given of the causes of these accidents.

I ought not to forget to mention that at Lyons, as at Lochrin, the top of the boiler, which was thrown to a distance of 330 yards had separated from the sides along a line nearly horizontal, although along this line the metal varied in thickness more than 8 hundredths of an inch. M. Tabareau, from whom I have copied these interesting details, has calculated that the additional thickness of 8 hundredths of an inch gave to the thickest parts of the metal an additional resistance of more than 6 atmospheres in 20 or 25, which was the total strength of the boiler. Thus there was a rent made at the same instant in parts of the boiler of which the strength differed six atmospheres at least.

I have just remarked, that the fact of the simultaneous explosion of several boilers placed over different furnaces is worthy of attention. It may be useful to cite another example of the same kind.

At the entrance to the tin mine of Polgooth, there is a large steam engine fed by three separate boilers. This machine having been stopped for a few minutes, to give the engineer an opportunity of repairing the air pump, two of the boilers immediately burst. Captain Reed, who was then near the mine, states that the noise of the first explosion had scarcely ceased when the second was heard.

Explosions caused by overloading the safety valve.

After the explosion which entirely destroyed the sugar refinery in Wellclose Square, London, it was found that the casting of which the boiler was made was not every where of a proper thickness. At the bottom the boiler was not less than $2\frac{1}{2}$ inches thick, on the two vertical faces an inch and a half, in the lower part of the cover

seven sixteenths of an inch only, in some other points not more than the eighth of an inch thick.

Some minutes before the accident, an agent of the constructor, disappointed at the want of power of the apparatus, notwithstanding the representations of the workmen of the refinery, had loaded the safety valve with an enormous weight, at the same time urging the fire as much as possible.

We may remark that at London, as well as at Lyons, the boiler burst in places which were so unequal in thickness, that if we represent by unity the force which would burst the thinnest parts, the thickest would resist a tenfold action.

During the inquiry instituted by the house of commons in 1817, into the circumstances of the bursting of a steam boat boiler at Norwich, Mr. William Chapman, a civil engineer of Newcastle, mentioned the bursting of a boiler caused, as in the preceding case, by an overcharge of the safety valve; a workman had seated himself upon the lever of the valve to exhibit to his comrades the see-saw motion which, he said, would take place as soon as the steam became strong enough to raise him. The valve was not raised, but the boiler burst. The fragments killed and wounded a number of persons.

In America the boiler of a steam boat on the Ohio burst while the crew were getting the boat under weigh, that is to say, when the machinery, not being in motion, no steam was consumed, the fire being raised in the furnace. To prevent accident, the safety valve should have been raised or the weight removed from it; through a strange mistake, the engineer had placed upon it an additional weight.

Explosions preceded by a great decrease in the tension of the steam.

In every case hitherto cited, except that of Lochrin, it has been proved that the safety valve was either completely shut, or loaded too heavily. The causes of these accidents seem evident. We are now about to enter into a detail of facts much less simple. Several of them, it must be confessed, seem at first paradoxical, and inspire doubt, but the examples are numerous, and the authorities on which they rest undoubted. Some minutes before the cast iron boiler of a low pressure engine in the factory of M. Feray, at Essones, burst, on the 8th of February, 1823, the engine supplied by it moved more slowly than usual, so much so that the workmen complained of it. Just before the explosion, the two safety valves had opened and the steam was issuing through them freely.

An accident in every respect similar to that of Essone, took place some days afterwards, on the boulevard of Mount Parnassus, Paris. Here, as at the factory of M. Feray, the workmen complained that the slow rate of the engine would enable them to accomplish but little work during the day, when suddenly the boiler, which was supposed to be nearly void of steam, burst. This boiler was of rolled copper. Nothing induced the suspicion that the safety valve was not in good condition, on the contrary, there is every reason to suppose that a free escape of steam preceded the explosion.

When the boiler of the steam boat Etna (America) burst, the piston was making but eighteen strokes in a minute. Usually, the number of strokes was twenty to the minute, thus the boiler burst under the pressure of a vapour sensibly less elastick than that which it usually contained.

On the day of the explosion in the steam boat Rapid, at Rochefort, the gauge had often indicated that the steam in the boiler would support 12 inches of mercury more than the atmospherick pressure; some minutes before the accident the gauge was at the height of only 6 inches.

The inquiry in relation to the explosion on board the steam boat Graham, showed that just before the accident, a weight of twenty pounds had been taken from the safety valve.

Explosions immediately preceded by the opening of the safety valve.

I will first observe that the bursting of the boiler at Essone might have been placed under this head, for the safety valve opened just before the explosion.

A low pressure boiler in a workshop at Lyons, burst immediately after a large aperture had been opened, by turning a cock, through which the steam began to issue with rapidity. To open this aperture was equivalent to raising the safety valve: here then an explosion was attendant on the very means which would seem most proper to prevent such an accident.

This fact, however strange it may appear, will be received without scruple, when I state that it is given by M. Gensoul, of Lyons, and further, that this skilful engineer witnessed the circumstance.

If in an extreme case, the opening of a safety valve may occasion the bursting of a boiler, it must frequently happen that though

no such effect should be produced by opening it, yet there may be produced a sensible and sudden increase in the elasticity of the steam; the action can, within such limits, be observed without danger. Such an experiment was made at Lyons upon a small high pressure boiler, and as soon as a large aperture for the escape of steam was made, by turning a cock, the safety valve was forced open. A contrary effect was observed by M. Dulong and myself at Paris, we always found a diminution in the tension of the steam caused by opening a valve; the experiment at Lyons is not the less certain, however, since it rests upon the authority of M. Sabareau, director of the school of la Martiniere, and of M. Rey, professor of chemistry. The probable causes of this disagreement which I shall explain hereafter, will show how the particular kind of accidents recorded in this article may be prevented.

Rending of boilers by a pressure from without.

Boilers constructed of plates of laminated copper or iron, low pressure boilers particularly, are subject under certain circumstances to accidents exactly the inverse of those which we have been engaged in describing.

These boilers are sometimes completely crushed, the sides bending to the pressure from without. Lyons and St. Etienne have been the theatres of several accidents of this kind, which should be guarded against if it were only to prevent whole factories from being reduced suddenly to a state of inaction.

The inner cylinders of boilers having the furnace and flues within, give way occasionally. They are unable sometimes to resist the pressure of the steam in the annular space around them, lose their shape, becoming flattened: this change of figure cannot take place without the metal giving way, and hot water thus escaping into adjacent rooms, produces dreadful havock. I shall quote an example of this sort from Mr. John Taylor, fellow of the Royal Society, London.

At the Mold Mines, in Flintshire, there is a large steam engine supplied by three boilers with interior flues. The machine was once stopped for five minutes; the engineer had raised the doors of the three furnaces and closed the registers in two of the flues; just as he closed the register of the third flue, he saw a burst of flame from the furnace into the room, and an explosion immediately followed. Two workmen who were in the direction in which the boiling water escaped, were killed instantly. A careful examination of the boiler showed that the exterior cylinder had not moved, nor had it suffered the slightest injury. The weight attached to the safety valve was also in its place after the accident. The interior cylinder had not moved from its place, as it sometimes does in this sort of explosion, but it was so flattened throughout the greater part of its length by the yielding of the lateral faces, that there was scarcely room to introduce the hand between them.

It may appear at first sight strange that I have placed an explosion proceeding from the too great elasticity of the steam within the boiler, in the same class with the inverse accidents described in the preceding paragraph, but it will be seen that these two effects have, to all appearance, a common cause.

Accidents peculiar to boilers with interior flues.

However little we may have studied the many causes of the explosions of steam boilers, and the varied combinations of them which are possible, we must have seen that to attempt to reduce them to fixed rules, would be out of the question. We may remark, however, that the form of the boiler is a prevailing cause, and determines the nature of the fracture. In this point of view, particularly, detailed and complete tables of the accidents of daily occurrence would be very useful. It appears from the tables published about two years since, by Mr. John Taylor, that in boilers of concentrick cylinders, or with interior flues, the faces of the interior cylinder are the weak parts. After the almost simultaneous explosion of the two boilers at the Polgooth tin mine, the interior cylinders of both boilers were found to have been twisted and rent in many places.

At the East-Crennis mine the interior cylinder was not only flattened by the crushing together of the upper and lower faces, but the cylinder was thrown with great force out of the building without the exterior cylinder having been moved, or having been badly rent. The preceding article contained a more striking example of the change of figure and rending of the interior flue* without injury to the exterior cylinder of the boiler.

* Popularly termed "the collapsing of the main flue." Such accidents are not uncommon in the high pressure boilers of the boats upon our western waters, usually of this construction. In the late accident on the Hudson, the interior flue gave way, allowing the boiling water to be pressed against the false front of the boiler, which was incapable of resisting violence.—Trans.

Explosion preceded by the boiler becoming too highly heated.

Too high a heat communicated to that part of the boiler which contains the steam may give rise to accidents. An example of this may be taken from an explosion which occurred at a foundry in Pittsburgh, America.

In this establishment a high pressure engine of eighty horse power was supplied by three separate cylindrical boilers, each being 30 inches in diameter, and 18 feet in length. It had been observed for some time, that owing to a defect in the pipe from the pump which supplied the boilers with water, one of them did not receive a sufficient supply, and became red hot, but as the two others furnished enough steam, they thought that it was unnecessary to repair the feeding pipe. This boiler receiving an insufficient supply of water, burst, the greater portion separated from one of the ends was projected under an angle of 45°, burst through the roof of the building, and fell about 600 feet from it.

Explosion of a boiler in the air.

We have rarely precise details of the circumstances accompanying the bursting of a boiler, either because the accidents have happened unexpectedly, and scarcely last some tenths of a second, or that those who have witnessed them have been victims to the accident. An attentive examination of local circumstances, of the mass remaining, of the fragments thrown from it, their distances, &c. will often serve to show what part of the boiler yielded first, and with what velocity the fragments have been thrown: usually our information stops here. It is of all importance then, to collect cares fully every thing which chance may throw in our way in relation to accidents so dangerous and so worthy of study. I therefore hasten to extract from a letter of Mr. Perkins, the following facts, which will not appear devoid of interest.

An explosion came to my knowledge, says this skilful engineer, which was preceded by a rent through which the steam escaped with great velocity. Notwithstanding this unexpected safety valve, the boiler was separated from the masonry upon which it was placed, was projected entire to some feet above the ground, and in the air the explosion took place which burst it in two. The upper half rose very high, the lower fell to the ground with great noise.

I am much mistaken if the same circumstances did not attend the Lochrin explosion.

It remains for us to ascertain from the preceding facts what the different causes are which have produced so many accidents, and the means of preventing their recurrence.

Necessity of providing safety valves: safety valves of Papin, its defects, accidents which such valves may prevent.

Florence Rivault, Solomon de Caus, and the Marquis of Worcester, had already remarked in 1605, 1615, and 1663, that a vessel, however strong its sides might be, containing water, if placed over a fire, would burst unless an opening was provided for the escape of the steam as fast as produced. The fatal experiment of Mr. Steel at Lyons, has too certainly shown the truth of this opinion. The temperature which will cause the rending of a vessel must depend upon its form and dimensions, and upon the tenacity and thickness of the material of which it is made. If we were sure that the heat of our furnaces could be kept below a certain limit, determined beforehand, no further precaution would be necessary than to effect this; but after observing, even but for once, the manner of supplying an ordinary furnace with fuel, how much the combustion depends not only upon the nature of the fuel, upon its size, upon the manner of placing it upon the grate, not to speak of the influence of the state of the atmosphere, we should immediately resign the idea of deriving from the furnace, means of preventing explosions.

We must then begin by supposing that a boiler entirely closed, and not of an enormous thickness, (there being more than one difficulty to be overcome before we can exceed certain limits in this particular) may contain, at times, steam of an elasticity greater than can be borne by the resistance of the faces. But to prevent this from happening is the only mode of preventing an explosion.

The safety valve invented by Papin seems to cut short all difficulty.

This safety valve consists of a hole, say of an inch square, made in the upper part of the boiler, upon which is placed a metal plate loaded with a certain weight. It is evident that the hole will remain closed as long as the pressure of the steam within the boiler is less than the weight of the valve, together with that of the atmosphere, upon the square inch, and that as soon as the pressure within shall exceed this, the valve will be raised and will give a free vent to the steam.

Let us now endeavour to ascertain how it may happen that so simple, so apparently reasonable a means, and one so easily executed, may not prove always efficacious.

The plate forming the valve rises the instant the weight with which it is loaded is exceeded by the pressure of the steam within the boiler, but to prevent any increase of elasticity in the steam within, this valve must further be of sufficient size to give vent to all the surplus steam. The escape of steam depends upon the diameter of the opening; and an opening which may be sufficient for ordinary occasions, may be much too small when accident causes the sudden conversion of a great quantity of water into steam. In such a case the valve may diminish the evil, but cannot prevent it. If the difficulties of adjustment, and the enormous weights required, did not set limits to the size of the opening, there would be a great advantage in using safety valves of very large openings. Without going too far, we may, I think, admit that hitherto we have used valves of too small a size. The justness of this assertion will not be doubted, especially if we recollect the curious observations recently made upon the flow of fluids through small apertures. It has been found that a light disk brought perpendicularly opposite to a current of steam flowing from an aperture made in a high pressure boiler, is not always repelled. At a short distance from the opening, the plate, which is urged by two opposite forces, the steam which tends to drive it from the aperture, and the pressure of the atmosphere acting towards it, remains, in consequence of the equilibrium of these two forces, suspended without motion. I cannot here examine how it happens that the steam loses in the very act of issuing, so great a part of its strength, that the pressure of the atmosphere counterbalances the remainder; I shall content myself with stating the fact that the plate is removed but a short distance from the aperture; the same thing will happen with the disk of the safety valve, and thus when it is raised, much less steam will issue than was calculated by assuming the vent to be of the size of the aperture closed by the valve.

M. Clement, who has studied these facts with great care, saw in them grounds for condemning the safety valve with a movable disk. This opinion goes perhaps too far, but it is certain that the partial rise of the valve offers an additional difficulty to be obviated by machinists, and the imperfect construction of the valve may sometimes be one among the causes of explosion.

Let us pass to difficulties of another kind.

In France the law requires that every cast-iron boiler, before it can be used, must have borne an interior pressure of five times the amount of the pressure under which it is to be used, and this pressure is reduced from five times to three times for boilers of rolled or hammered iron. These limits seem great, and often excite complaints on the part of machinists; we shall see, however, that they are far from affording entire security.

The boilers are proved at ordinary temperatures, at which, the metals have a greater tenacity than when heated. As they approach a white heat, the diminution in tenacity is enormous. The experiments of M. Tremery, for example, have proved that the tenacity of forged iron at a dull red heat is but one-sixth part of that of the same metal when cold. If then, by mishap, any part of the boiler should become red hot, the metal would be near the point of rupture, *without the safety valve being raised*, although from experiments made upon the boiler when cold, we should have a right to believe it far from that point.

But why, it may be said, not make a decisive experiment? why not place the boiler exactly in the circumstances under which it is to be used; why, in a word, not substitute steam for water in proving it? The answer is, that by the aid of a pump the boiler may be proved any where, even in the workshop of the person who made it, with but little apparatus, and at a slight cost; whilst to prove it by steam, would, on the contrary, require the building of a furnace for every boiler, and a large place for the purpose; we paralyze the arts when we surround them with such trammels. Add to this that the experimenters using the pump run little or no danger even when the boiler gives way, but that this would not be the case were the trial made by steam. The precautions which it would be necessary to take in this latter case to secure the experimenters from danger would add much to the difficulty and expense of this preparatory trial. It seems, then, that the trial by the pressure of water, notwithstanding the defects which I have already mentioned, and those which yet remain to be explained, will continue to be used.

When we act upon the faces of a boiler by a forcing pump, the interior pressure is

increased very gradually; this trial gives us no information in relation to the resistance of these faces to a considerable pressure suddenly applied, but to these abrupt changes of pressure it may be exposed in practice.

Further we may remark, that these trials made upon a new boiler, show what it can bear when new, not what it will be able to sustain after some weeks or some months use, after inequalities of temperature have strained the metal in every direction, and disunited its fibres, after rust has acted upon it, &c. &c.

To recapitulate, we have found that notwithstanding the proper construction and good condition of a safety valve, a boiler may explode: 1st. Because the opening of a safety valve is not sufficient to give vent to the steam which is generated suddenly, and in great quantity.

2nd. Because the boiler has been proved when cold, and when heated, particularly when it reaches a high temperature, the tenacity of the metal is much lessened.

3d. Because an *abrupt* increase of pressure, produced gradually, may occasion rupture in cases were a greater pressure had been attended by no evil consequences.

4th. Lastly, because the boiler is injured by exposure to the fire, and after a few months the tenacity of the metal composing it, is often much diminished.

A safety valve, however well constructed, can never warrant the engineer in neglecting to prove his boiler from time to time, nor can it warrant him in not endeavouring to prevent, by all the means in his power, abrupt changes in the elasticity of the steam, and in not preventing the boiler from, at any time, being too strongly heated.

I have supposed, hitherto, the safety valve in good order; in fact, it would seem, at first, difficult for so simple a contrivance to get out of order; but when we consider that the movable disk often rusts, and that it acquires in consequence of this action, particularly when at rest, a strong adhesion to the metal upon which it rests, we can see that it may not move under pressures much above those fixed upon to be attended with the escape of steam. Mr. Maudslay, whose skill and experience are well known, said that a safety valve no longer deserved its name when it had been left without being moved for a week; he placed near some of his boilers a cord within reach of the firemen, by which he could raise the safety valve from time to time. It has been contrived to produce such a motion by means of levers worked by the machinery, but when the boiler is not near to the working parts of the engine this is not practicable.

The firemen are generally ordinary labourers without prudence, who too often overload the safety valves either to quicken the working of the engine, or to make a parade of their courage. This danger may be avoided; perhaps the greatest danger which is to be feared, by having always two safety valves to every boiler, the one under the control of the fireman to be used whenever the steam is to be let off; the other to be inclosed by a grated box, of which the engineer, or the proprietor of the engine, should have the key. The use of two safety valves was recommended almost unanimously by a number of engineers examined before a committee of the house of commons in 1817; in France, a royal ordinance makes this precaution absolutely essential. Perhaps it would be well to require that each boiler should be provided with some simple contrivance, conveniently placed, by which the fireman could ascertain from time to time that the disk of the valve moved freely; those who are used to visiting workshops know that workmen are with difficulty induced to perform those operations which leave no mark of their performance, unless they can be done easily.

Plates of fusible metal.

As soon as it was found that the common safety valves sometimes get out of order, and did not present a certainty of security, it was proposed to replace them by an entirely different contrivance, the action of which, should never be uncertain. This was the fusible metal valve, described in the Annuaire for 1829.

To understand rightly the use of these valves, we should know that it is possible that steam should have a very high temperature and but little elasticity, but not possible that a great degree of elasticity should not be accompanied by a high temperature.

Experimenters have determined the lowest temperature necessary for steam to acquire a tension of one, two, three, ten, &c. atmospheres. By using these results we can know what temperature the steam must not surpass after we have fixed upon the pressure. If we then cover an opening in the boiler with a plate made of an alloy of lead, tin, and bismuth, in proportions such that the alloy will melt at the limit of temperature fixed upon beforehand, this temperature can never be exceeded, for on reaching it the plate melts and gives vent to the steam.

In France a royal ordinance requires that every boiler shall be provided with two fusible plates of unequal sizes. The fusing point of the smaller is 10° (18° Fah.) above the temperature of steam, having an elasticity equal to that which the steam to be used in the engine should have. The second plate fuses at 10° (18° Fah.) above the first.

Although many cases may be cited in which fusible plates have probably prevented explosions, they are employed unwillingly by most, preference being given to the common valves, with which, in addition to the plates, the boilers must be provided. Let us then examine the objections to these plates.

It was said at first that since these plates were affected by temperature, and not by pressure, they might melt when the steam within was very hot, but not elastick in proportion; but this can only happen when the vapour is not saturated with moisture, that is, only when there is not a sufficient supply of water within the boiler, then a portion of the boiler must become heated, perhaps even to redness, and then there is imminent danger of an explosion; this first objection seems, therefore, to be refuted.

The plate does not approach the point of fusion without being softened; it is, therefore, to be feared that it may give way under a tension much less than that which would produce its fusion. At the outset this actually did take place, but the difficulty has been obviated by covering the plate with a wire gauze, with small meshes, before it is fixed by bolts to the aperture which it is to close. Even now, parts of the plate yield partially, swelling out in different places as the fusing point approaches; but experience has shown that it is only very near to this point that the metal yields entirely, opening a free passage to the steam.

When the fusible plate has been melted, all the steam escapes through the opening which it closed. It may take some time to replace it, to fill anew the boiler, and to heat the water, and during this time the engine stands still. In a steam boat, in certain cases, this sudden absence of the moving power might occasion serious accidents. This is a real and a great difficulty, and perhaps is the reason why our neighbours have not adopted the fusible metal valve, but give preference to the ordinary safety valve. These, it is true, never suffer all the steam to escape. If they open, it is only when the elasticity of the steam within has passed a certain limit; as soon as this elasticity has returned within this limit, fixed by the engineer beforehand, they fall, closing the aperture; thus the moving power can never fail entirely.

The advocates of the fusible metal plates considered as one of the highest advantages of these valves the physical impossibility of changing their limit of action; thus, placing them beyond the reach of imprudent workmen. It is true, that with these plates, all overcharge, in the literal meaning of the word, would be useless; but when the firemen wish to urge their fires more than usual, they understand how to prevent the fusion of the plate, by directing a constant stream of cold water upon it; so that in this point of view perhaps we have gained nothing.

Thin plates.

A safety valve is in fact nothing but an artificial weakening of a certain part of the boiler. It has been proposed to weaken the boiler by covering small holes, made for the purpose, with laminated plates of metal, of which the thickness should be calculated so that they should burst under pressures of one, two, three, ten, &c. atmospheres, according as we should have determined not to exceed two, three, four, eleven, &c. atmospheres in the pressure of the steam within the boiler. It is evident that the bursting of so small and so thin a plate would never cause any serious accident.

This mode, however specious it may appear, has rarely been used, either because it is not easy to determine, experimentally, the thickness of the plate which for a given size of aperture would burst under a given pressure, or because we cannot be certain of having plates identical in strength. The thin plate is more out of the power of the workmen when in place, than the fusible metal valve, it may, it is true, be weakened, but can never be strengthened; and this is the important point. In this point of view the thin plates are to be preferred to the fusible metal disks; they have an inconvenience common to the latter, namely, that of suffering the escape of all the steam when they have given way.

Gauge valve.

The gauge tube, (a syphon tube, the shorter leg communicating with the boiler, while the longer, open at the end, contains a column of mercury,) may be made to perform the office of a safety valve, and it answers

the purpose better than either the common valve, or the fusible plate. The common valve shows nothing of the pressure within until it rises, the fusible plate shows nothing until it melts. The fireman learns suddenly that he has reached the limit which he must not go beyond, but was not warned of his approach to it. The gauge, on the contrary, gives him every moment the measure of the elasticity of the steam; it indicates low as well as high pressures.

The disk of the common safety valve may have lost its power of moving without the fact being known, whilst, on the contrary, if impurities should stop the gauge tube, the want of motion in the mercury would show it immediately; it is plain that in so large an apparatus as a boiler, and from which the steam does not escape constantly, but at short intervals, the elasticity cannot be constant; the boiler and gauge tube communicating, every fluctuation in the steam produces an oscillation in the mercury of the gauge.

The mercurial gauge should then be considered as the best safety valve yet invented, provided its diameter is sufficiently great. Whenever its too great length does not render it inapplicable, it may be considered as a safe-guard in cases where the best constructed common safety valve, or the fusible metal plate would have proved a protection against accident. The reader will see the reason for this restriction, when I shall have shown that there are cases in which the opening of the valve may cause an explosion.

Internal, or air valves: their object.

At the time of lighting a fire under a boiler, the space within the boiler, not occupied by water, is filled with atmospherick air. This air, mixed with steam, passes by degrees into the engine fed by the boiler, and at last is completely expelled therefrom. Things being in this state, suppose the working of the machine to be stopped, and the fire suffered to go down, the steam will be gradually condensed as the cooling proceeds, and after some time the space which it once occupied will be almost void. The boiler is then pressed inwards by the pressure of the atmosphere, without there being any interior pressure to counterbalance the action. When the condensation of the steam takes place slowly, it ought not to cause accidents, since the weakest boilers should have been proved under a pressure, directed from within outwards it is true, of not less than five atmospheres. The consequences might be serious, however, if the condensation were sudden; for example, if a jet of cold water should play into the steam; then, in an instant of time, the pressure of the atmosphere ceasing to be counterbalanced, would produce the effect of a percussive force upon the whole surface of the boiler, and would crush the boiler in the way already spoken of in relation to the interior flue of certain kinds of boilers. To prevent such accidents, interior valves, called also air valves, were invented. This valve opens inwards. It is kept in its place by a spiral spring within the boiler, the strength of the spring being a little more than equal to the weight of the valve. Or else it is suspended horizontally to the arm of a lever placed on the outside of the boiler, so arranged that the valve exactly touches the interior face of the opening, which it is to close. With this arrangement the elasticity of the steam within the boiler can never become less than that of the atmosphere without the immediate opening of the valve, which will admit air into the boiler; thus when the engine is stopped, having performed its task, there can be no fear that a vacuum will be formed within the boiler. It seems to me that we cannot so safely conclude that the same arrangement would prevent, certainly, the crushing of the boiler, for such accidents result from a great and abrupt diminution of elasticity in the steam. The gradual action of a valve might, to a certain extent, lessen the evil, but could not prevent it. There is but one remedy against such accidents, to watch carefully the means of feeding the boiler, and to prevent the reservoir of steam within the boiler from being suddenly cooled, as would happen, for example, if a quantity of cold water should be thrown upon the exterior. The crushing of the flues within certain boilers would be easily explained if we could prove that sometimes a vacuum is suddenly formed in the smaller cylinder, but as this cylinder does not contain steam; as it forms only the furnace and its flue, we should have had, perhaps, some difficulty in finding how a vacuum could be produced, if the circumstances of the explosion at the Mold Mines had not led us to it.

We must recollect that at the time of that accident, the door of the furnace was open, while the register of the chimney was closed; that after closing this register a burst of flame issued from the furnace into the room, and the explosion immediately followed.

With the door of the furnace open the combustion could hardly have been active, and the current of air which rose through the chimney could scarcely have been chemically changed. When the register was closed the air no longer flowed in, but that which the chimney already contained remained there shut up. The coal in the furnace was not yet extinguished; the gas which it contained continued to be disengaged, and to mix with the air of the chimney; its proportion soon became sufficient to render the mixture inflammable; it inflamed; escaped in this state through the only vent which remained, namely, the door of the furnace; in an instant the small cylinder was, if not entirely void, as the cylinder in Brown's vacuum engine are after a similar inflammation, filled with a gas highly rarefied.

I am much mistaken if this explanation, by Mr. John Taylor, does not give the true key to the frequent crushing of the small cylinders of boilers with interior cylinders. It is important, therefore, when we use that kind of boiler, not to close the register doors until the coal is extinguished. Paltry considerations of economy cannot have weight where there is so evident a danger, and this danger cannot be prevented by interior valves.*

(To be continued.)

COMMUNICATION.] [FOR THE MAGAZINE

FILTERED WATER.

Mr. Editor,—The plan for supplying families with water from reservoirs to be made in our streets, to which I alluded in your last number, under the head of "Filtration Upwards," is but a part of a plan which I proposed several years ago, for the special purpose of extinguishing fires. That plan, after two or three years' consideration, was adopted by the city government, with alterations which I, as the projector, did not altogether approve of. Instead of the large, deep, and expensive reservoirs, which have been constructed in some of our streets, my proposition was to construct a larger number, of much smaller dimensions, and less deep, and to have them connected together by leaden tubes, laid so low in the ground as to be below the common surface of the water in the reservoir, with the ends of these tubes turned downwards, to near the bottoms of the reservoirs; so that when the water was taken from one of these reservoirs, the tubes connecting it with the others, on both sides, should first supply the deficiency, simply by running until the level of the water in the whole line of reservoirs was equal, and as high as the summit of the intervening tubes; and then to continue running, on the principle of the syphon, which thus would do, (being always charged,) so long as the surface of the two adjoining reservoirs was higher than the one which was under exhaustion. By this arrangement I expected several advantages over the plan which has been adopted by the city. The present mayor of this city approved my plan, I believe, and recommended its consideration to the former administration, by which it was adopted in part.

The advantages which I expected, were these. First, a greater supply of water, and that more generally diffused through the city without any additional expense; for the materials and labour of one large reservoir, would give several small ones, and being connected, they would leave disposable the contents of all at any given point. The importance of this disposition will be understood by those who know the advantage of having a supply of water at hand, in the beginning of a fire, over that of a much greater quantity when the fire has made some progress. The next advantage expected, was from a reduction of labour in raising the water into the engines from a smaller depth, rather than from a greater. This also appeared to be of some importance, when the great labour of drawing and forcing the water is taken into consideration. It is apparent that the inferiour depth of the reservoirs, and the continuous supply from either side of the whole line, combined, would have kept the water near the surface of the ground much longer than with the deep and isolated reservoirs.—These latter, too, are confined, in their sources of supply, to one or two neighbouring houses; whereas, the long line of small reservoirs, would embrace a great number of houses.

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* These remarks are applied to a case in which bituminous coal was the fuel. They would apply equally well to all cases in which the fuel yields a combustible gas, as, for example, to pine wood during the first period of its combustion, to rosin, wet charcoal, &c.

An explosion was produced in a common close stove, in this city, by covering a fire of anthracite with wet ashes; on relighting the fire with shavings and charcoal the following morning, an explosion took place in a drum connected with the stove, and placed in the second story of the house, of which the stove occupied the ground floor; part of the drum was thrown with violence against the ceiling of the room.—Trans.

The idea of this means of supplying the city with water, was suggested to me by a recollection of the principal source of supply for culinary purposes and for washing, in the city of Cadiz; which was, when I was there, a very populous place, but of very small extent. That city was then supplied by stone reservoirs, notwithstanding there is no rain there for the greater part of the year. It is known that the water from the front part of our houses runs to waste; it therefore appeared to me, that an ample supply might be obtained in this way, and thus supersede the necessity of an expensive aqueduct. This was the tenure of my proposition, at the time, in one of our papers.

The object of the present communication, is to show the possibility of supplying families with an abundance of water, much more pure than that which we now use; and at the same time to increase the supply for the fire department without any expense to the city government.

Let it be lawful for any proprietor to construct a small brick reservoir, in the street, opposite to his house, to receive all the water that can be brought into the same, from his own, and his neigbours houses, when they can so agree. This would reduce the expense to a trifle, if the reservoirs were distant, from one to two hundred feet, such length would embrace several houses. Then each contributor on this line should have the right to tap the reservoir, or the connecting tube, to a certain depth only, and to conduct it into his cellar. Before it entered the cellar, or after, as might be most convenient, the water should be made to pass through a filtering box, upwards, as described in your preceding number, in the article on filtering.

If I am not deceived, the cost of such a supply of water, would be much less than what we now pay to the aqueduct corporation.

By limiting the draught to a certain depth, the fire department would be always sure of a supply in the driest times. And those elevated streets, to which the aqueduct cannot reach for the want of sufficient head, would be thus supplied without encroaching on the yards, which, in modern lots, have no room to spare.

The arguments which were probably used in favour of those large reservoirs which have been adopted in this city, might have been very plausible, and quite sufficient to decide in their favour, a mere mathematician. Such a one would have decided the case by referring to a known principle in geometry; whereby it is found that the area contained within given surrounding parts, increases as the squares of those surrounding parts; therefore, large vessels contain more in proportion to their walls, than smaller ones. But this principle was not the only element to be brought into the decision; nor should it have been a governing one; since the ratio of *utility*, in a given quantity of water at the beginning of a fire, over a larger quantity soon after, is vastly greater than the geometrical ratio alluded to; whose only advantage in the case, is an economy of bricks and mortar.

False economy is a more common failing than might be supposed, among individuals who have the light of interest to guide them. And that economy, which would substitute bad water for good, for almost any purpose, is an egregious error. In washing, soap and labour more than balance any supposable saving on the water. In distilling, or in any chymical operations, and even in cooking, soft and pure water, saves time, labour and fuel; and does, in fact, what hard water cannot do. But in the preservation of health; I will not suppose that the most refined miser would consider the health of his family a fair object to exercise this economy upon.

Much of the water now used in this city, is not only impregnated with saline, and calcareous substances; but from the carelessness of our constructions, the water of our wells is exposed to every sort of adulteration. It would be better for the city that our wells were in the streets, than to be exposed to such impurities as they now are: But even there, the looseness of the earth would often expose the water to adulteration. Rain water is certainly the lightest, and the easiest to be made quite pure by filtration; I should therefore prefer it, as far as it can be had, even to water which might be brought from any distant source, subject to be injured by large manufacturing establishments.

The following lecture, relative to linear conductors of sound, is of considerable interest; it was delivered before the Royal Institution of Arts and Sciences, at one of their recent meetings.

The science of the transmission of sounds

is always a pleasing one, and one of peculiar interest to the scientifick ear.

A pleasant effect of transmitted sound may be witnessed at the Dry Dock, now building in the Charlestown Navy Yard. Nearly all round the chamber of the dock, and inside of the walls, brick culverts, terminating in a large reservoir, are built, the length of which, including the reservoir, is about 580 feet. This passage conveys sound with surprizing distinctness; a whisper at one end being audibly heard at the other. Clapping of the hands had an almost astounding effect; the sound appeared to strike forcibly against the upper part of the culvert, or reservoir, (which is about 11 feet high, and 7 wide,) and then rebound, to either entrance, with a deep undulating tone. Our extract says:

The fact of the transmission of sound through solid bodies, as in the case of a metal rod placed at one extremity to the ear, and struck or scratched at the other end, has been long since observed; but as an aerial medium was formerly thought to be alone capable of propogating sonorous undulations, even Lord Bacon, when describing this experiment, falls into the error of attributing its transmission to spirits contained within the pores of the body. The first correct observations on this subject appear to have been made by Dr. Hooke, in his Micographia, (1667;) and he made an experiment through a distended wire of sufficient length to observe that the same sound was propagated far swifter through the wire than through the air. Professor Wunsch, of Berlin, (1788) made a similar experiment, substituting 1728 feet of connected wooden laths for the wire, and confirmed Dr. Hooke's results. Other experiments of a similar nature were subsequently made by Herhold and Rafn, Hassenfratz and Gay Lussac, Lamarck, &c; but the first direct observations of the actual velocity of sound through solid conductors were made by Biot, assisted at different times by Bouvand and Martin: his experiments were made on the sides of the iron conduit pipes of Paris, through the length of 951m 25; and the mean result of two observations made in different ways gave 3,459 metres, or 11090 feet per second, for the velocity of sound in cast iron. Previous to these direct experiments, Chladni had, in an ingenious manner, ascertained the velocity of sound in different solid substances; and his result has been fully confirmed by calculations from other grounds. His method was founded on Newton's demonstration, that sound passes through a space filled with air, of a given length, in the same time that a column of air of the same length, contained in a tube open at both ends, makes a single vibration. Chladni's discovery of the longitudinal vibrations of solid bodies, which are exactly analagous to the ordinary vibrations of columns of air, enabled him to apply this proposition to solid bodies, and to establish the general law, that sound passes through every body in the same time in which that body, when it vibrates, freely makes one longitudinal vibration. In this manner he ascertained the velocities of the following substances, among others: tin, 7,800; silver, 9,300; copper, 12,500; glass and iron, 17,500; and various woods, from 11,000 to 18,000 feet per second. The intensity with which sound is transmitted has been found to be nearly in proportion to its velocity. Some known practical applications of this principle were then noticed; such as the stethescope, microphone, &c. In all the preceding experiments, the sounds transmitted, were mere noises, such as the blow of a hammer, or, as in Herhold and Rafn's experiment, a single musical sound, produced by striking a vibrating plate attached to the conducting wire; and in no case were any means employed for the subsequent augmentation of the transmitted sound. Mr. C. Wheatstone was the first who tried experiments on the transmission of the modulated sounds of musical instruments; and who shewed that the undulations propagated through linear conductors of considerable length, were capable of exciting in surfaces with which they are in connexion, a quantity of vibratory motion, sufficient to be powerfully audible when transmitted through the air. The following observations will illustrate the nature of this resonance or reciprocation. A sonorous body is audible in proportion to the quantity of its vibratory surface. Thus, a plate of metal or wood is capable of producing powerful sounds without accessory means; but insulated strings, or tuning-forks, being vibrating bodies of much smaller dimensions, are scarcely audible at any great distance; but they are capable of considerable augmentation when communicated to surfaces, as when the insulated string, or the tuning-fork, is placed on a table, or in the sound-

ing-board of a musical instrument. There are several circumstances which influence the intensity of the tones of a sounding-board: the principal of these is the plane in which the vibrations are made, with respect to the reciprocating surface. Thus, the vibrations may be so communicated as to be perpendicular or normal to the surface: in which case the sound is the most greatly augmented; or they may be tangential to, or in the same plane with the surface, when the sound is the most faint. These two cases may be illustrated by placing, for the first, a vibrating tuning-fork perpendicular to the surface of a flat board; for the second, placing it perpendicular to one of the edges of the board. In intermediate positions, viz: when the vibrations are communicated obliquely to the surface, the sounds have intermediate degrees of intensity. These facts being understood, the peculiarities of the sounding-boards of various musical instruments admit of easy explanation. In the piano-forte, the sounding-board is better disposed than in any other instrument, as the planes of the vibrations of the strings are always perpendicular to its surface. The difference of intensity when a string vibrates in this way, and when it vibrates parallel to the surface, may be easily tried. In the sounding-boards of the harp, the guitar, the violin, &c. the circumstances are less simple; but it would encroach too much on our space to enter into details. Sufficient having been said to illustrate the subsequent applications, we will only add, that the volumes of air contained between the sounding-boards of a musical instrument greatly augment the intensity of the sound. The office of the bridge is obviously to communicate the vibrations of the strings to the sounding-board. Aware of this fact, Mr. Wheatstone substituted a glass rod five feet in length for the bridge, and found that the sound of a tuning-fork, or of an insulated string, placed at its end, was as distinctly audible as when it was immediately in contact with the board. This experiment, which was the first Mr. W. made on this subject, and which suggested all the subsequent ones, was repeated in the lecture-room, by substituting a deal rod forty feet in length, extending from the roof of the cupola to the floor of the room. The experiment was neat and decisive. When no sounding-board was placed at the lower extremity of the conductor, no sound was heard; but it became powerfully audible the instant the communication was made: this experiment was repeated with different acute and grave-toned tuning-forks, both in succession and in combination. As the sounds employed in these experiments are only audible when they become augmented by resonant surfaces after transmission, it is easy to repeat them, and to appreciate their results, under any circumstances; but when it is required to transmit the sounds of a musical instrument, it is necessary to prevent the sounds being heard through the air, otherwise the communicated sounds will not be distinguishable from the original sounds: this may be effected by having the originally vibrating and the reciprocating instruments in different rooms, and allowing the conductors to pass through the floor or wall separating the two rooms. This experiment was tried, by communicating, by means of a slender deal rod, the sounding-board of a harp in the lecture-room with a piano-forte in a room below; and the performance of the latter was transmitted in the most perfect manner to the former instrument: and when the communication was interrupted, the transmitted sounds ceased. The construction of the lecture-room did not admit of the experiment being tried in the way first employed by the experimenter; viz. the sounds transmitted from a piano-forte in a chamber above, by a wire of a very small diameter, to a lyre suspended from the ceiling.

The transmission of the sounds of other stringed instruments, such as the harp, violin, violoncello, &c., were found to be equally effective. But Mr. W. did not confine his experiments to the transmission of the sounds of vibrating sounding-boards: he discovered also the means of transmitting the sounds when produced from wind instruments. He observed that the peculiar sounds of a clarionet, or other reed instrument, were not to be attributed either to the column of air or to the vibrating tongue alone, but that they mutually influenced each other, in such a manner, that whether the sounds are communicated to the atmosphere from the column of air, or to a conductor from the vibrating tongue, the quantity of the sound undergoes no change. The transmission of the sounds of reed wind instruments he therefore found as perfect as those of instruments dependent on the vibrations of sounding-boards. In other classes of wind instruments, the difficulties of transmission are greater; for it is not possible to transmit the vibrations of the

air immediately through solid conductors with any degree of intensity; but if the intermediation of other bodies which enter readily into vibration, from the agitations of the air, be employed, the transmission may be effected. Thus, if the end of the conducting wire be placed in the most strongly vibrating part of the column of air in a flute, there is but little perceptible transmission of sound; but if it touch the sides of the instrument, it will more readily transmit the sounds in proportion as the sides are more susceptible of entering into vibration. In a similar manner, the sounds of an entire orchestra, or of the human voice, may be transmitted, viz. by connecting the end of the conductor with a sounding-board so placed as to resound to the various instruments; but in such cases the sounds are by no means so intense as when they are communicated directly from the instruments. The effect of such intermediate transmission was exemplified by some performances on Mr. W.'s new instrument, the symphonion. A few observations were then made on various proposed applications of this principle, and on the possibility of telephonick communication. It was stated, that as sound has been proved to travel through several conducting substances at the extraordinary velocity of 18,000 feet in a second, were it possible to transmit audible sound so far, a phonick communication might be made between London and Edinburgh—a distance of nearly 400 miles—in less than two minutes. Theoretical considerations have shewn, that when sound is communicated without any divergence through a perfectly elastick body of equal density throughout, its energy suffers no diminution; it follows, therefore, that the more perfectly we can approximate to these conditions of a conducting body, the less limitation there will be to the transmission of the sonorous undulations. But these points can be determined only by extended experiments.—(London Lit. Gaz.)

MECHANICK ARTS IN CHINA.

The perfection of the mechanick arts in China cannot be denied in certain instances; but this is evidently not the result of a regular combination of scientifick improvements.—It appears to be the effect of the laboured experience of ages, brought slowly and difficultly to a certain point, where it is stationary and cannot advance further, until science shall dispel the prejudices of habit and the clouds of ignorance. There is certainly a superiority in several of their silk manufactures, as it regards the gloss and the fixing of the colours, and the rendering them so bright and permanent; but this is not produced by any secret mordant process unknown to Europeans. I was once present at the dying of silks; and on examination, found the process conducted in the simplest manner, with the commonest mordants used in England. Owing to the cheapness of labour, a very large number of hands are employed; therefore the work goes on with a rapidity almost beyond conception, and the silks are hung out to dry during the prevalence of the north wind, called by them *Pak Fung*. Certainly, in any other climate and under different management, more time would be required, and that circumstance would suffice to alter very much the appearance of the colours. The Chinese never attempt to dye any fine silks with rich colours until Pak Fung commences, which generally happens towards the last of September or beginning of October. This wind is so remarkable in its effects, and so immediately felt, that should it begin at night, even when all the doors and windows are shut, the extreme dryness of the air penetrates into the house, and furniture and floors begin to crack with a noise almost as loud as the report of a pistol. If the floors have been laid down in the summer when the air is damp, or if the planks be not exceedingly well seasoned, and secured with iron clamps, they will open an inch at least when the north-east monsoon commences. The Chinese will not even pack teas or silks for exportation in damp weather, that is to say, unless they are hurried to do it by the strangers who have business with them, and wish to get their ships away sooner than ordinary. I have known a ship detained three weeks longer than the captain wished at Canton, because the security-merchant would not pack the silk which formed part of her cargo until the weather became favourable. This will account, in some measure, not only for the permanency and beauty of the dye, but likewise for the care that is taken to preserve it. The Chinese say, that if newly dyed silks be packed before they are perfectly dry, or in damp weather, they will not only lose the brightness of their colour, but will also become spotted. They may have some secret in the spinning and tissue of silks which we know nothing of; but certainly not in dyeing them.—*Dobell's Travels.*

HYDROPHOBIA.

Facts, like the following, should not be permitted to sink into the common grave of the many productions of the present day. To keep such valuable information afloat on the broad surface of our periodicals should, we think, be the duty of every one

interested in the welfare of fellow men.—The article is from that inestimable work, Silliman's Journal of Arts and Sciences, No. 35, p. 204.

"We are indebted to a highly valued medical friend, for the following interesting communication. The importance of the subject on which it treats, will, no doubt, obtain for it an extensive circulation. The writer is a man of science and worthy of every confidence."—*Ed. U. S. Tel.*

At the present moment our fellow citizens are considerably excited by the fear of mad dogs, by whom at least two children, in this city [Washington] have, within a few days, been bitten. The horrible nature of the disease consequent to the bite—a disease so utterly beyond the reach of medical aid, renders it the imperious duty of every one to communicate to the publick any thing he may know tending to mitigate or prevent the awful issue.

By the late foreign medical Journals we learn that M. Coster, a French surgeon of great eminence, has devoted his attention to the subject of animal poisons. He has discovered that chlorine has the wonderful power of decomposing and destroying the poison of the most deadly.

The saliva of the mad dog, has the property, when inserted under the skin, of communicating hydrophobia to other animals, and to man. M. Coster has been able, by the use of chlorine, to decompose this deadly poison, and render it harmless, preventing the approach of hydrophobia in animals bitten by dogs decidedly rabid.—There can be no doubt of the accuracy of the experiment on which this statement is predicated.

From this the most important practical results follow:

Make a strong wash by dissolving two table spoonfuls of the chloruret of lime in half a pint of water, and instantly and repeatedly bathe the part bitten. The poison will in this way be decomposed. It has proved successful when applied within six hours after the animal has been bitten.

I wish these facts generally known, as they may be of service to our fellow citizens at large.

Singular case of Hydrophobia.—A case is related in the Lancet, a London Monthly Periodical, of a man having died with all the horrors of hydrophobia, and the dog that had bitten him betraying no such symptoms. The statement is from an eminent surgeon, and is well attested by several respectable names. Soon after the man was bitten, he applied to a medical gentleman, intimating, however, his firm conviction that the dog was not mad. As the dog was evidently sick, the surgeon took the precaution of having him placed in a secure situation, and from day to day watched the progress of his symptoms till he died. From the most attentive observation, the surgeon could not observe the slightest appearance of *rabies;* the animal lay quiet, walked firmly, breathed easily, had no abhorrence of fluids, and caressed his master as usual. His death appeared to be accompanied with pain, and on being opened, the body presented none of those appearances which are generally produced by *hydrophobia.* In about a fortnight after the decease of the animal, the man was taken with the usual symptoms of *rabies*, and died in dreadful convulsions. The case has excited considerable interest, as it proves that hydrophobia, in animals, is not confined to one character, but assumes different shapes.

Remarks on the above cases and on the uses of the chlorick preparations by Professor Silliman.

We have added the account of the last hydrophobick case, for the purpose of saying, that it might be prudent in every instance of a bite from a dog, or other animal, whether supposed to be rabid or not, to wash the wound frequently with the solution of chloride of lime. From what we now know of the powers of chlorine, it is not too much to hope for, that it may prove an antidote to every case of poison, provided it be applied in season, and before the system is fatally affected.

It appears highly probable that hydrogen, from its being the lightest and most subtle of all known ponderable bodies, may enter into the composition of such active agents as poisons. Fontana examined the poison of the viper and of other animals, but we know not whether, as in prussick acid, hydrogen is the active principle. Chlorine destroys the effect of prussick acid*, the

*M. Dauvergne, in a letter to *M. Gay Lussac*, dated Paris, April 25th, 1829, states, that M. Simeon, apothecary to the hospital Saint-Louis, poisoned a cat with hydrocyanick acid, by placing two drops in the corner of his eye; the animal was violently affected, and when to all appearance past recovery, a large quantity of chlorine was diffused in his throat, which very soon alleviated the symptoms, and when able to raise his head, which before he could not do, he ap-

most active poison known, even after it has gone far towards producing death. It is therefore credible, that it may destroy other poisons, having a similar constitution; and we can readily understand the *modus operandi* in such cases; for chlorine takes hydrogen from every combination, and of course destroys the peculiar character of the compound. Prussick acid itself consists of nothing but the ordinary elements of animal matter, such as are daily used for food; but in the acid they are combined in a peculiar manner, and the withdrawing of hydrogen from it, at once subverts the combination, and renders it harmless.

The practical use which we would make of the facts which we know, and of the theoretical views which we entertain, is, that chloride of lime should be kept in every family ready for instant use in the multiplied cases in which it is applicable.

It is already manufactured in this country in large quantities, and we observe with great satisfaction, that it is hereafter to form a part of the stores of our ships of war. This will greatly encourage the manufacture, and the time is not distant, when the price will be much less than at present.†

We would observe that as there are various chlorick preparations, and of course an endless diversity of cases in which they may be applied, we should not give over, even should they not prove effectual in every instance; for some variety in strength, and mode of preparation, and application, may be necessary to accommodate the remedy to different cases.

BOSTON RAIL-ROAD MEETING.

A large and numerous meeting of the citizens of this ancient metropolis of New-England, in its corporate capacity, was holden on Monday, July 12th, on the great subject of a rail-road from this city to the western states, at which an able and elaborate report was made by a highly respectable committee from the twelve wards of the corporation, chosen at a previous meeting of the people, and which concluded by recommending the adoption of the resolutions appended at the close of this article, and which were debated throughout the forenoon, when their further consideration was postponed until the first Monday in August ensuing. A very decided sense was expressed in favour of the resolutions; it was only urged, that a vote so important in its character should not be adopted without due consideration; that although a vote of precisely a similar nature was passed in February, 1829, (3000 voting in the affirmative, and 50 only in the negative,) still, as there had since arisen doubts in the minds of some of the citizens as to the constitutionality of the city taking the interest proposed by the report, and that it was no more than an act of comity to such, to say the least of it, to allow them a further time to make known the grounds of this opinion; for which purpose a motion was adopted, that the report be printed, when a further discussion could take place at the adjournment, and at another meeting the balloting proceed by yeas and nays on each of the resolutions. The result of such meeting, we cannot but think, will be in favour of the passage of the resolutions, whether by the decided vote before referred to, or not, time, of course, only can determine. We think the city will be safe in an affirmative on this, we confess, great and momentous question. What will be the course? The city will only be in the way of means; no interests are compromitted; an application goes to the legislature for a general act authorizing any city or town to subscribe in the manner proposed; if any doubt exists there as to the constitutionality of such a measure, that body has a right to require the opinion of the judges of the Supreme Judicial Court; if that opinion should be adverse, we shall be just where we were, (with one advantage to be named presently,) the whole subject will then be open for the adoption of such measures as true wisdom and sound policy may then suggest. By this time, such farther developement on the great subject of rail-roads will doubtless have been made, as shall inspire more confidence in them on the part of either the state, or the good citizens of Boston and the Commonwealth, in their private capacity, to undertake the great enterprize. At any rate, we cannot but hope, that *what will then remain* of the energies of the metropolis, as this city has been in times past emphatically called, will be put forth for this purpose, so

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peared to take pleasure in smelling the chlorine, from the relief which it afforded. In an hour he rose on his feet, and in the course of two hours more, scarcely any traces of morbifick symptoms remained. The experiment has been tried on various other animals, with similar results.

† We understand about eight or nine dollars per cwt.—double this rate or a little more, at retail.

that the great work of a r[illegible] from Boston to the Hudson, an o[illegible] long and ardently desired, will be carried into a speedy and successful operation.

The following are the resolutions above referred to:

1. *Resolved*, That it is expedient for the city of Boston to make application to the legislature of the Commonwealth for an act, authorizing said city to subscribe for and take shares of stock in a rail-road, to be established in a direction calculated to facilitate an intercourse between Boston and the western states, and to such an amount as said city shall deem proper, *provided* the amount taken shall not exceed *one million of dollars.*

2. *Resolved*, That the *city council* be requested and instructed to prepare and present to the general court at an early day of the next session, a petition for an act granting the authority aforesaid.

3. *Resolved*, That the senators of the county of Suffolk, and the representatives of the city of Boston, be requested to exert their influence to promote the passage of such an act.

A distant correspondent has sent us a drawing and description of a machine purporting to be a rotary steam engine. This contrivance, although ingenious, is inferior to the *crank motion*, now in use, for converting a *reciprocating motion* to a *rotary one*; in fact it is not, strictly speaking, a rotary engine, it having a lever beam as in the common engine.

We think, however, this plan might be adapted to a mangle, for converting a rotary motion to a reciprocating one, if the clutches can be made to act with precision, and be secure. A chain, or rope, should be attached to the centre of the large segment, to draw the movable part of the mangle backward and forward.

We are always glad to receive communications of this character; they lead to inquiry if nothing more; and in submitting them to the scrutiny of the publick their true merits are more satisfactorily discovered. Our friend has our best wishes for his success in the mechanical arts; we should be glad to hear from him again.

Cement for Hard Stones, Porcelain and Glass.—This cement is a natural product, which, without being abundant, is in sufficient quantities for all ordinary uses. The large snails which are found in gardens and woods, and are sometimes used for food, have a vesicle at the extremities of their bodies filled with a whitish substance, having a greasy and gelatinous appearance. If it be applied between two surfaces, whatever be their hardness or compactness, and the surfaces be brought together throughout, so strong an adhesion is ultimately occasioned, that if violent blows or thrusts be given to the substances, they frequently break elsewhere than at the junction. A flint about the *size of a fish* having been broken into two pieces, and rejoined by these means, being thrown with violence on the pavement, broke into fragments by fresh fractures crossing the former junction, but not going along with it. All that is necessary to give this cement its full power is to allow it time to dry.—(Quarterly Journal.)

Instantaneous Light Apparatus.—Amongst the different methods invented in latter times for obtaining a light instantly, ought certainly to be recorded that of Mr. Walker, chemist, Stockton, upon Tees. He supplies the purchaser with prepared matches, which are put up in tin boxes, but are not liable to change in the atmosphere, and also with a piece of fine glass-paper folded in two. Even a strong blow will not inflame the matches, because of the softness of the wood underneath, nor does rubbing upon wood or any common substance, produce any effect except that of spoiling the match; but when one is pinched between the folds of the glass-paper, and suddenly drawn out, it is instantly inflamed. Mr. Walker does not make them for extensive sale, but only to supply the small demand that can be made personally to him.—(Idem.)

Cleansing Sewers.—In a valuable paper, containing an elaborate description of the method pursued under the direction of a commission of able chemists appointed by the police of Paris, it is stated that the most important advantages were derived from the use of chloride of lime as a counteracting agent. The most efficacious mode of employing it was found to be the scattering of hay through different parts of the sewer, and sprinkling the chloride of lime upon it. It was gradually dissolved in the moisture, and diffused its anti-septick qualities through the atmosphere of the sewer.—(Am. D'Hygiene.)

Iron Works of Sweden.—The account of exportation of iron from Sweden during the year 1828, in tons of 1000 kilogrames each, (2200 lbs.) was as follows:—

United States,	9,409	tons
Germany,	6,676	"
Great Britain,	5,753	"
France,	5,096	"
Portugal,	3,200	"
Denmark,	1,771	"
Low Countries,	1,436	"
Indies,	893	"
Russia,	350	"
Brazil,	289	"
Malta,	142	"
Spain,	64	"
Antilles,	58	"
Italy,	40	"
Norway,	35	"
Total,	35,213	tons

The value of which, in the Swedish ports, is from ten to eleven millions of francs, (2 to 2 1-5th millions of dollars.)

This is about one fifth of the total production of France. In Sweden, the only fuel with which the forges are supplied, is wood; of course the fabrication is limited to the annual production of this combustible, and cannot be increased as in forges supplied with pit coal. Hence, if the demand for Swedish iron should rise much above what it is at present, it is probable that the price would augment rather than the production increase. We have not much satisfactory information on the metallurgick resources of Sweden; and it appears that in relation both to art and economy, we have much yet to learn from them. This knowledge would come very seasonably at a time when our forges are calling for important ameliorations, and capital is waiting only to be secure in its results. (Rev. Encyc.)

It appears, by the following extract from Professor Silliman's Journal, that anthracite coal is a valuable ingredient in the material made use of in making bricks: it renders the burning more perfect and uniform, and improves their texture and durability:

"The materials for the making of brick at Newburgh, Cornwall, and Haverstraw, do not differ materially in any respect except colour, which in some places is blue, in others yellow. The clay is a heavy, tenacious loam, consisting principally of argil, some silex and oxide of iron. I have found, by experi[illegible]t it contains so little calcareous ea[illegible]t no effervescence takes place when it is submitted to the action of dilute marine acid. This clay is prepared in the usual manner; being first dug from the pit, and then frequently turned for some time and exposed to the air and frost, for at least one season. When it has undergone this necessary preparation, it is again turned and tempered by treading; in this state it was formerly the custom to prepare it for moulding; but since the discovery of the value of an intermixture of a certain quantity of anthracite coal, the clay should be deposited in layers of five or six inches, on which is laid the proper proportion of anthracite coal, powdered and skreened through a wire skreen, the opening of which should not be so much as half an inch wide; it should thus be mixed in alternate layers with the prepared clay, and duly and regularly incorporated with it, previously to its being moulded in the form of bricks, which are at first dried in the air, and afterwards placed in the kilns in the usual manner, to undergo the process of burning. Kilns of the average size, contain about one hundred thousand bricks; to burn these effectually in the accustomed manner, required about forty-five cords of good wood, and the operation was seldom completed in less time than ten or twelve days.

The value, however, of this new method of burning the brick becomes now apparent, as the process of burning, which formerly took ten or twelve days, is now completed in five, and instead of its consuming forty-five cords of valuable wood, it requires not more than fifteen cords, whilst at the same time the bricks are more completely and equably burnt to the centre, and as far as we can at present judge by experience, they are rendered as hard and as durable as the English brick. Thus, a saving of thirty cords of wood, valued here at one hundred and fifty dollars, is made in the burning of one hundred thousand bricks, while the process of burning them is completed in half the time.

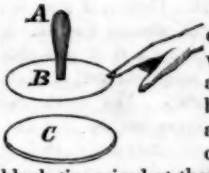
Some time since, I detailed the effect of some experiments which were made in Boston several years ago, on the value of anthracite coal in the burning of brick, which were not successful in consequence of the intense heat which was produced by the use of an over quantity of it, vitrifying part of the contents of the kiln; the same effect would be produced even in the man-

ner now recommended, if too great a proportion of it was intermixed with the brick earth. I have seen this take place and several of the bricks altered in shape and converted into scoriæ, a sort of semi-vitrification taking place in the centre. As far as present experience affords a criterion of judging, it will not require half the quantity of powdered anthracite coal to produce the same effect as is generally allowed of coal ashes in England; less than half a ton of anthracite coal will be sufficient for one hundred thousand bricks, while seven hundred and fifty bushels of breeze and ashes are allowed in England for the same number. The price of this sifted anthracite or refuse coal is scarcely worth mentioning, as it is not calculated for domestick use, and in Rhode-Island, in particular, is found an incumbrance by the proprietors of the colliery. But it should be understood that the principle upon which the value of each depends, is nearly the same; the anthracite is nearly a pure carbon, unmixed with any ashes, and not being deprived of any part of its carbon by being partly consumed in the grate, as is the case with respect to the cinders of bituminous coal, much less of the anthracite will therefore be required to produce the intended effect; it should also be made much finer, by passing it through a smaller skreen, otherwise, in the process of burning, particles of it will remain unconsumed, rendering them liable to crack and blister, as I have occasionally noticed. In the regulation of the quantity of the anthracite coal, attention must also be paid to the nature and qualities of the earth which is used for the manufacture of brick; if it is nearly a pure argil with a proper proportion of silex only, vitrification in the kiln will not so easily take place, and more of the coal dust may consequently be mixed with it; but if the earth contains a large proportion of calcareous matter it forms a mixture of a very fusible nature, and consequently not so suitable for good brick, nor requiring the same proportion of coal. The test of submitting a little of this earth to the action of marine acid may easily be made use of, by any individuals, in calculating the quantity of anthracite which it would be proper to mix with the clay in the composition of brick.

It has occurred to me, and I would suggest that great advantage and economy in the process of burning would arise, if the interstices between the different layers of bricks in the kiln were filled with small coal, thus assisting in thoroughly and uniformly burning all parts of the brick and improving their quality. It appears to me that no danger would attend this method, nor would vitrification take place if proper care was taken; this practice prevails in England, where the coarser cinders, which are not allowed to pass through in skreening, are constantly made use of, by strewing them between contiguous layers of the brick, as they are built up, tier upon tier, in the kiln.

I have thus endeavoured to lay before the publick the principal details of this new process in brick making, the advantages of which can scarcely as yet be duly appreciated; further experience in the use of it will doubtless tend to render it more perfect. It appears to me however sufficiently decided, that by adopting the use of anthracite coal, in the manner pointed out, a saving of time and expense may hereafter be calculated on, sufficient to reduce the price of this indispensable article in building, nearly fifty per cent., besides rendering their texture and quality superior to those which have heretofore been manufactured in this country."

THE ELECTROPHORUS.



The handle A is either of glass, or of wood with a glass nut at the bottom, (made black in the diagram,) and is fixed to the circular plate B, made of block-tin, wired at the edge, or, if elegance is required, of polished and lackered sheet-brass. The lower plate C may be made of a variety of substances; but I give the neatest and best. Get a circular board turned of any hard wood that will not warp, about half an inch thick; then melt in a ladle several ounces of common sealing-wax, and pour it, in a liquid state, over one side of the wood, so as to cover it completely. Make the surface level by heat; a hot smoothing-iron, or a kitchen "salamander," held at a little distance over it, answers admirably. Coat the opposite side of the wood with tinfoil, and the work is complete. To put it in action, take a piece of warm flannel, and rub *con spirito*, the sealing-wax: then place upon it the tin-plate, holding it by the handle. Touch the plate with the finger (it will not do without) as represented in the sketch; take the finger off, and then raise the plate by the glass handle, and it

will give out a strong spark, which may be communicated to a Leyden jar.

Many pretty experiments may be done with this little apparatus, besides stunning a man's arms up to the shoulders. Being once well rubbed, it will continue in full action several hours, without being rubbed again: this is one of the most curious circumstances attending it. The description of all its powers fills upwards of four quarto columns in the "Encyclopedia Britannica." Of course, the larger the two plates are made, the greater will be the power; 9 or 10 inches in diameter is a very good size, and it is recommended that the lower plate be about one inch more in circumference than the upper. With one of these dimensions, an active operator may charge a pint jar in one minute, so as to perforate 10 or 12 sheets of paper, &c.

P. S.—A portion of glass tube or rod, or a stick of sealing-wax, will do instead of the handle, if neatness is no object.—(Lond. M. Mag.)

Phosphorescence of the sea in the Gulf of St. Lawrence.—Capt. Bonnycastle, R. E. whilst coming up the gulf, on the 7th Sept. 1826, observed this phenomenon, under the following interesting circumstances. At two o'clock, A. M. the mate, whose watch it was on deck, suddenly aroused the captain in great alarm, from an unusual appearance on the lee bow. The night was star light, but suddenly the sky became overcast in the direction of the high land of Cornwallis county, and a rapid, instantaneous and immensely brilliant light, resembling the Aurora Borealis, shot out of the hitherto gloomy and dark sea on the lee bow, and was so vivid that it lighted every thing distinctly, even to the mast head. The mate, having alarmed the master, put the helm down, took in sail and called all hands up. The light now spread over the whole sea between the two shores; and the waves, which before had been tranquil, now began to be agitated. Captain B. describes the scene, as that of a blazing sheet of awful and most brilliant light. A long and vivid line of light, superior in brightness to the parts of the sea not immediately near the vessel, showed us the base of the high, frowning and dark land abreast of us; the sky became lowering and intensely obscure. The oldest sailors on board had never seen any thing of the kind to compare with it, except the captain, who said that he had observed something of the kind in the Trades. Long tortuous lines of light in a contrary direction to the sea, showed us immense numbers of very large fish darting about as if in consternation at the scene. The sprit-sail yard and mizen-boom were lighted by the reflection as though gas lights had been burning immediately under them; and until just before day break, at four o'clock, the most minute objects in a watch were distinctly visible. Day broke very slowly, and the sun rose of a fiery and threatening aspect. Rain followed.

Captain B. caused a bucket of this fiery water to be drawn up; it was one mass of light when stirred by the hand, and not in sparkles, as usual, but in actual corruscations. A portion of this water kept in an open jug preserved its luminosity for seven nights. On the third night the scintillations in the sea re-appeared, and were rendered beautifully visible by throwing a line over board and towing it along astern of the vessel. On this evening the sun went down very singularly, exhibiting in its descent, a double sun: and when only a few degrees above the horizon, its spherical figure changed into that of a long cylinder which reached the horizon. In the night the sea became nearly as luminous as before. On the fifth night the luminous appearance nearly ceased.

Capt. B. is unwilling to attribute the above effect to living animalculæ; but suggests the idea that it depends upon some compound of phosphorus suddenly evolved and dispersed over the surface of the sea. In such a compound he conceives the phosphorus or phosphorick acid to be afforded by exuviæ or secretions of fish, and the other constituents to be in some way connected with those abundant oceanick salts, the muriate of soda and sulphate of magnesia.—(Trans. Lit. and Hist. Society of Quebeck. Vol. i.)

A Remarkable Watch.—M. Rebiller has made a watch, all the wheels of which, and every portion of the works are visible from the outside. The case, the bridges, and many of the wheels are of rock crystal, a substance perfectly transparent, and little inferior in hardness to the gems.

The screws are tapped in the crystal itself; all the holes are sunk in rubies; the piece which forms the escapement is of sapphire; the balance wheel is of crystal.

When the difficulty of working in such a substance, on a scale requiring so much

delicacy as a watch, which may be suspended from a lady's neck, is duly considered, one can scarcely conceive how the maker could succeed in a work of this nature. It is a *bijou* of remarkable elegance, and the only one hitherto executed. M. Rebiller assures us that it keeps time almost as well as a chronometer, and he attributes this effect to the balance wheel being of crystal, and the hair spring of gold: substances but little affected by temperature.—(Rapport fait par Francœur. Bull. d'encour.)

Mr. Walter M'Adam, watchmaker in Bathgate, has lately constructed an 8-day clock on an entirely new principle. The clock has only one barrel, and both goes and strikes the hour by the impulse of a single spring. The contrivance is exceedingly ingenious, and, at the same time, very simple: so simple, indeed, that one wonders, after seeing it, how the idea had never occurred before.—(Stirling Journal.)

Plumbago, instead of Oil, in Watches and Chronometers.—M. Hebert appears to have well ascertained that plumbago, well prepared by rubbing and repeated washings, to remove all the particles of gravel which are more or less found in the best specimens, is preferable to oil in watch movements. It is applied with a hair pencil, either in powder or mixed with one or two drops of pure alcohol. It adheres promptly to a pivot of steel, as well as to the surface of the hole in which it turns, so that the rubbing surfaces, no longer present a metal to a metal, but plumbago to plumbago; they acquired a polish which yields only to that of the diamond; the retardation from friction and the wearing becomes almost nothing. An astronomical clock made by M. Hebert, the pivots and holes of which, and the teeth of the escapement had been covered on their surfaces with fine plumbago, fourteen years before, was taken apart and examined by a committee of the London Society of Arts. The surfaces of plumbago were found, for the most part, entire and perfectly polished, and a strong magnifying glass discovered not the slightest wear, either in the pivots or the holes.—(Trans. Soc. of Arts, 46, p. 48.)

The Pantouranion.—A valuable astronomical instrument, invented by Mr. W. Shires, the mathematical tutor, in January, 1829, has been since improved by the same author, and rendered capable of finding its own meridian, the right ascension, declinations, longitudes, and latitudes of any celestial object; the day of the month and hour; the hourly, daily, and annual variations; the state of refraction, moon's parallax, and precession of the equinoxes. It will also direct the observer in finding any planet, &c. mentioned in the "Nautical Ephemeris;" will point out the fixed stars, foretell eclipses, and, in a word, will form of itself a complete observatory. The instrument is an improvement on the equatorial of Mr. Shires; the principle of which, as first conceived, was explained to the Western Literary Institution.

Native Silver from the Mines of Pasco.—Professor Silliman, in the last Number of his Journal, describes a box of specimens from the mines of Pasco, which he had recently an opportunity of examining. Among numerous pieces of native silver there is "one pure and solid piece, without pores or intermixture, seven inches long, five and a half broad, and from three to two and a quarter thick; its weight exceeds 14 lbs. avoirdupois; and its value, as *silver merely*, is over 230 dollars." The Professor adds, "It appears to be a fine exhibition of the full dimensions of a rich vein or cavity of virgin silver, as it has the natural faces by which it was joined to the rock.

COMMUNICATION.] [FOR THE MAGAZINE.

Mr. Editor,—There is among soapmakers a great want of theoretick information in regard to their business, which cannot well be acquired by any one engaged in the practice of a profession which leaves but little leisure, especially as all that has been published on the subject, which is known to me, is of a very general and indefinite character.

As it is possible that the subject has engaged the attention of some one of your scientifick correspondents, I would respectfully request, if there is any such, that he would publish, in the Magazine, the true theory of the combination of alkalies with fatty substances, together with any other information, bearing upon the business, which it may be convenient to communicate.

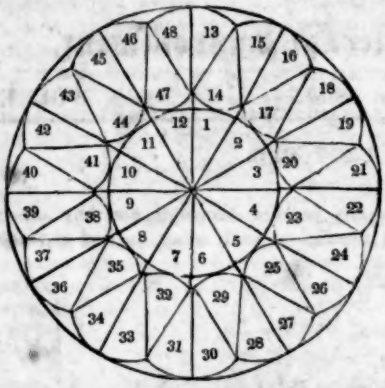
If, Mr. Editor, you think the object of this communication sufficient to justify it, you will very much oblige me by inserting it. G.

Answer to the Mathematical Question proposed in No 4, page 123.

Sir,—I have attempted to find a rule by which a cooper may cut a large bottom into four equal bottoms without losing much stuff.

The areas of circles are in proportion to each other as the squares of their diameters,

therefore a circle will contain four circles each equal to half its own diameter; but, since the whole of the stuff in the present case cannot be used, the diameters of the small circles must be something less than half that of the large circle.



Rule,—Divide the circumference of the large bottom into twelve equal parts, draw lines from each of these divisions to the centre; divide the radius into one hundred equal parts, take forty-nine of these parts for the radius of the small circles; from the centre of the large circle describe one of the small ones, with the same radius describe thirty-six sectors in the space between the small circle, and the outer edge of the large circle, if these sectors have the same radius and arc they will produce circles which are equal to each other.

There are forty-eight sectors in the figure, twelve for each circle.

In another figure that had seventy-two sectors I found that a radius of forty-nine and a half hundreds would answer, and the greater the number of sectors used the nearer we should approach to the truth which would be just half that of the large circle. T. C.

COMMUNICATION.] [FOR THE MAGAZINE.

Extract from my Note Book.—Explosion.

Thursday, Oct. 2, 1817.—A man in the employ of ———, being in the habit of repairing locks for a water company, brought a cast-iron guide to the shop, in order to get a wrought-iron one made from it; he took it to the forge to burn the grease off; in drawing it through the fire a slight explosion took place, which only caused a kind of laughter among the men; they supposing it to proceed from the coals on the fire. The man proceeded, and in about two minutes another explosion occurred, I believe with a report as loud as a soldier's musket, blowing the cinders off the forge in all directions, and frightening some of the men. Curiosity led me to examine into the cause. The piece of iron was about twelve inches long, one inch wide, and five eighths of an inch thick. I found two cavities in the iron, answering to the two explosions; one being much larger than the other.

However, I could not determine whether the explosions were caused by inclosed *air*, or *water* converted into steam, as the large cavity was very bright, and not oxidated. T. C.

Query.—Would not a few drops of acid, put into a grindstone trough with the water, improve the cut of the stone, by acting on the iron or other metal that might be on its surface?

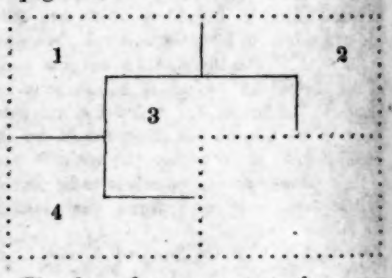
An accident that occurred lately, in this city, has suggested this inquiry.

MATHEMATICAL QUESTIONS.

Supposing the earth a sphere, 25,000 miles in diameter, and a person starts at the 60° N. latitude, and travels N. 55° W. 3000 miles, what will then be his distance, in a right line, from the place where he started?

If a cubick foot of brass were drawn out into wire 1-40th of an inch in diameter; required the length of the wire, supposing no loss of metal.

Answer to Mathematical Question, No. 1, at page 160.



The above figure represents the manner in which the remainder of the land is to be divided, so that the four parts shall be equal and similar to each other.

The writer of the "Address to the Carpenters of Boston," will excuse us for not publishing the same, as we think it not altogether suitable for our pages.

A box, for the reception of communications, has been placed upon our door.